

**Table 1.** Biological, Chemical, and Physical Evaluations Conducted during the LANL Water Quality Assessment, 1996-1997.

### BIOLOGICAL EVALUATIONS

#### ***Biological Inventory***

Wildlife Reported in Study Area  
 Electrofishing Survey  
 Aquatic Life Reported in the Study Area  
 Benthic Macroinvertebrate Survey  
     Taxa Density and Richness  
     Diversity Indices  
     Community Metrics

#### ***Biological Response***

Surface Water Toxicity Testing  
     Using a 96-hour Static Renewal Test  
         with laboratory invertebrates/fish  
     *In Situ* Caged-fish 96-hr & 2 months  
 Sediment Toxicity Testing  
     Using a 96-hour Test of Porewater  
         with laboratory invertebrates  
 Contaminant Bioavailability  
     Metals/PCB accumulation in biota

### CHEMICAL EVALUATIONS

<b><i>Field and Laboratory Analyses</i></b>	<b>Nutrients</b>	<b>Minerals</b>	<b>Dissolved Oxygen</b>	<b>pH</b>
Continuous Monitoring		X	X	X
Grab Water Samples	X	X	X	X
Porewater	X	X	X	X
<b><i>Chemical Analyses</i></b>	<b>Organics</b>	<b>Metals</b>	<b>Radionuclides</b>	<b>Explosives</b>
Water Samples		X	X	X
Porewater		X	X	
Sediment	X	X		X
Benthic Macroinvertebrates		X		
Caged Fish	X	X		

### PHYSICAL EVALUATIONS

#### ***Instream Characteristics***

Width and Depth  
 Flow and Discharge  
 Substrate  
 Cover

#### ***Habitat Conditions***

Habitat Type (e.g., pool, riffle, run)  
 Riparian Vegetation  
 Habitat Stability

#### ***Watershed Characteristics***

Stream Channel Stability  
 Land Use and Land Cover  
 Air & Water Temperature  
 Water Uses & Discharges

#### ***Habitat Suitability Models***

Brook Trout Life Cycle Habitat Suitability Index  
 Longnose Dace Adult Habitat Suitability Index  
 Rapid Bioassessment Protocol for Invertebrates

**Table 2.** Wildlife Species Reported in the Jemez Mountains and Characterized by Life Cycle Dependency in Water.

COMMON NAME	SCIENTIFIC NAME	Source <sup>1</sup>	GUILD <sup>2</sup>			
			Fully Aquatic	Semi-aquatic	Riparian	Terrestrial
<i>Fish of the Jemez Mountains</i>						
Rio Grande Cutthroat Trout	Oncorhynchus clarki virginalis	1,2	yes	no	no	no
Rainbow Trout	Oncorhynchus mykiss	1	yes	no	no	no
Brown Trout	Salmo trutta	1,2	yes	no	no	no
Brook Trout	Salvelinus fontinalis	1,2	yes	no	no	no
Rio Grande Chub	Gila pandora	1,2	yes	no	no	no
Fathead Minnow	Pimephales promelas	1	yes	no	no	no
Longnose Dace	Rhinichthys cataractae	1	yes	no	no	no
Rio Grande Sucker	Catostomus plebeius	1,2	yes	no	no	no
White Sucker	Catostomus commersoni	1	yes	no	no	no
<i>Additional Fish of the Rio Grande (above Cochiti Reservoir to the Rio Chama)</i>						
Red Shiner	Cyprinella lutrensis	1,3	yes	no	no	no
Common Carp	Cyprinus carpio	1,3	yes	no	no	no
Flathead Chub	Platygobio gracilis	1,3	yes	no	no	no
River Carpsucker	Carpodacus carpio	1,3	yes	no	no	no
Black Bullhead	Ameiurus melas	1,3	yes	no	no	no
Channel Catfish	Ictalurus punctatus	1,3	yes	no	no	no
Mosquitofish	Gambusia affinis	1,3	yes	no	no	no
Green Sunfish	Lepomis cyanellus	1,3	yes	no	no	no
Bluegill	Lepomis macrochirus	1,3	yes	no	no	no
Smallmouth Bass	Micropterus dolomieu	1,3	yes	no	no	no
Largemouth Bass	Micropterus salmoides	1,3	yes	no	no	no
Black Crappie	Pomoxis nigromaculatus	1,3	yes	no	no	no
Yellow Perch	Perca flavescens	1,3	yes	no	no	no
Walleye	Stizostedion vitreum	1,3	yes	no	no	no
<i>Amphibians of the Pajarito Plateau</i>						
Jemez Mountain Salamander	Plethodon neomexicanus	4,5	no	no	no	yes
Tiger Salamander	Ambystoma tigrinum	4,5	no	yes	yes	no
New Mexico Spadefoot	Spea multiplicata	4,5	no	yes	yes	no
Red-spotted Toad	Bufo punctatus	4,5	no	yes	yes	no
Woodhouse's Toad	Bufo woodhousii	4,5	no	yes	yes	no
Canyon Treefrog	Hyla arenicolor	4,5	no	yes	yes	no
Western Chorus Frog	Pseudacris triseriata	4,5	no	yes	yes	no
Bullfrog	Rana catesbeiana	4	no	yes	yes	no
Northern Leopard Frog	Rana pipiens	4	no	yes	yes	no
<i>Lizards of the Pajarito Plateau</i>						
Collared Lizard	Crotaphytus collaris	4,5	no	no	yes	yes
Short-horned Lizard	Phrynosoma douglasii	4,5	no	no	no	yes
Prairie Lizard	Sceloporus undulatus	4,5	no	no	no	yes
Tree Lizard	Urosaurus ornatus	4,5	no	no	yes	yes
Chihuahuan Spotted Whiptail	Cnemidophorus exsanguis	4,5	no	no	no	yes
Checkered Whiptail	Cnemidophorus grahami	4	no	no	yes	yes
Little Striped Whiptail	Cnemidophorus inornatus	4,6	no	no	no	yes
New Mexico Whiptail	Cnemidophorus neomexicanus	6	no	no	no	yes
Plateau Striped Whiptail	Cnemidophorus velox	4,5	no	no	yes	yes
Many-lined Skink	Eumeces multivirgatus	4,5	no	no	yes	yes
Great Plains Skink	Eumeces obsoletus	4,5	no	no	yes	yes

**Table 2.** Wildlife Species Reported in the Jemez Mountains and Characterized by Life Cycle Dependency in Water ~ Continued.

COMMON NAME	SCIENTIFIC NAME	Source <sup>1</sup>	GUILD <sup>2</sup>			
			Fully Aquatic	Semi-aquatic	Riparian	Terrestrial
<i>Snakes of the Pajarito Plateau</i>						
Ringneck Snake	Diadophis punctatus	4,6	no	no	yes	yes
Great Plains Rat Snake	Eleaphe guttata	4,5	no	no	yes	yes
Night Snake	Hypsiglena torquata	4,5	no	no	no	yes
Smooth Green Snake	Lioclorophis vernalis	4,5	no	no	yes	yes
Coachwhip	Masticophis flagellum	4,5	no	no	yes	yes
Striped Whipsnake	Masticophis taeniatus	4,5	no	no	yes	yes
Gopher Snake ("Bull Snake")	Pituophis melanoleucus	4,5	no	no	yes	yes
Mountain Patch-nosed Snake	Salvadora grahamiae	4,5	no	no	yes	yes
Blackneck Garter Snake	Thamnophis cyrtopsis	4,5	no	no	yes	yes
Western Terrestrial Garter Snake	Thamnophis radix	4,5	no	no	yes	yes
Western Diamondback Rattlesnake	Crotalus atrox	4,5	no	no	yes	yes
Western ("Prairie") Rattlesnake	Crotalus viridis	4,5	no	no	no	yes
<i>Mammals of the Jemez Mountains</i>						
<i>Shrews</i>						
Dwarf Shrew	Sorex nanus	6,7	no	no	yes	yes
Masked Shrew	Sorex cinereus	7	no	no	yes	no
Water Shrew	Sorex palustris	8,9	no	no	yes	no
<i>Bats</i>						
Townsend's Big-eared Bat	Plecotus townsendii	7,8	no	no	yes	yes
Big Brown Bat	Eptesicus fuscus	7,8	no	no	yes	yes
Big Free-tailed Bat	Nyctinomops macrotis	7,8	no	no	yes	yes
Brazilian Free-tailed Bat	Tadarida brasiliensis	7,8	no	no	yes	yes
California Myotis	Myotis californicus	7,8	no	no	yes	yes
Fringed Myotis	Myotis thysanodes	7,8	no	no	yes	yes
Hoary Bat	Lasiurus cinereus	7,8	no	no	yes	yes
Long-eared Myotis	Myotis evotis	7,8	no	no	yes	yes
Long-legged Myotis	Myotis volans	7,8	no	no	yes	yes
Pallid Bat	Antrozous pallidus	7,8	no	no	yes	yes
Western Pipistrelle	Pipistrellus hesperus	7,8	no	no	yes	yes
Silver-haired Bat	Lasionycteris noctivagans	7,8	no	no	yes	yes
Western Small-footed Myotis	Myotis ciliolabrum	7,8	no	no	yes	yes
Spotted Bat	Euderma maculatum	7,8	no	no	yes	yes
Yuma Myotis	Myotis yumanensis	7,8	no	no	yes	yes
<i>Hares, rabbits, and pikas</i>						
Desert Cottontail	Sylvilagus audubonii	6,8	no	no	yes	yes
Nuttall's Mountain Cottontail	Sylvilagus nuttallii	8	no	no	no	yes
Pika	Ochotona princeps	7,8	no	no	no	yes
<i>Squirrels, Gophers, and relatives</i>						
Colorado Chipmunk	Tamias quadrivittatus	7,8	no	no	no	yes
Least Chipmunk	Tamias minimus	7,8	no	no	no	yes
Abert's Squirrel	Sciurus aberti	7,8	no	no	no	yes
Golden-mantled Ground Squirrel	Spermophilus lateralis	7,8	no	no	no	yes
Spotted Ground Squirrel	Spermophilus spilosoma	7,8	no	no	yes	yes
Red Squirrel	Tamiasciurus hudsonicus	7,8	no	no	yes	yes
Rock Squirrel	Spermophilus variegatus	7,8	no	no	yes	yes
Gunnison's Prairie Dog	Cynomys gunnisoni	7,8	no	no	no	yes
Botta's Pocket Gopher	Thomomys bottae	7,8	no	no	yes	yes

**Table 2.** Wildlife Species Reported in the Jemez Mountains and Characterized by Life Cycle Dependency in Water ~ Continued.

COMMON NAME	SCIENTIFIC NAME	Source <sup>1</sup>	GUILD <sup>2</sup>			
			Fully Aquatic	Semi-aquatic	Riparian	Terrestrial
Northern Pocket Gopher	Thomomys talpoides	7,8	no	no	no	yes
Mice, Rats, and Voles						
Brush Mouse	Peromyscus boylii	7,8,9	no	no	yes	yes
Deer Mouse	Peromyscus maniculatus	7,8,9	no	no	yes	yes
Western Harvest Mouse	Reithrodontomys megalotis	7,8	no	no	yes	yes
House Mouse	Mus musculus	7,8	no	no	yes	yes
Pinyon Mouse	Peromyscus truei	7,8	no	no	no	yes
Plains Pocket Mouse	Perognathus flavescens	6	no	no	no	yes
Rock Pocket Mouse	Chaetodipus intermedius	6	no	no	yes	yes
Silky Pocket Mouse	Perognathus flavus	7,8	no	no	yes	yes
Northern Rock Mouse	Peromyscus nasutus	7,8	no	no	no	yes
White-footed Mouse	Peromyscus leucopus	7,8,9	no	no	yes	yes
Bushy-tailed Wood Rat	Neotoma cinerea	7,8	no	no	no	yes
Mexican Wood Rat	Neotoma mexicana	8,9	no	no	yes	yes
White-throated Wood Rat	Neotoma albigula	7,8,9	no	no	yes	yes
Long-tailed Vole	Microtus longicaudus	7,8,9	no	no	yes	yes
Meadow Vole	Microtus pennsylvanicus	7,8	no	no	yes	yes
Montane Vole	Microtus montanus	7,8,9	no	no	yes	yes
Red-backed Vole	Clethrionomys gapperi	7,8	no	no	yes	yes
New Mexican Jumping Mouse	Zapus hudsonius	7,8	no	no	yes	yes
Beaver, Raccoon, Ringtail, Skunk and Porcupine						
Beaver	Castor canadensis	7	no	yes	yes	no
Raccoon	Procyon lotor	7,8	no	yes	yes	yes
Ringtail	Bassariscus astutus	8	no	no	yes	yes
Striped Skunk	Mephitis mephitis	7,8	no	no	yes	yes
Porcupine	Erethizon dorsatum	7,8	no	no	yes	yes
Dogs and relatives						
Coyote	Canis latrans	6,8	no	no	yes	yes
Gray Fox	Urocyon cinereoargenteus	7,8	no	no	yes	yes
Red Fox	Vulpes vulpes	8	no	no	no	yes
Bear						
Black Bear	Ursus americanus	7,8	no	no	yes	yes
Weasels						
Ermine Weasel	Mustela erminea	7,8	no	no	no	yes
Long-tailed Weasel	Mustela frenata	8	no	no	yes	yes
Black-footed Ferret	Mustela nigripes	8	no	no	no	yes
Cats						
Bobcat	Lynx rufus	7,8	no	no	yes	yes
Mountain Lion	Felis concolor	7,8	no	no	yes	yes
Deer and Elk (Wapiti)						
Mule Deer	Odocoileus hemionus	7,8	no	no	yes	yes
Elk	Cervus elaphus nelsoni	7,8	no	no	no	yes
Other mammals						
Feral Burro	Equus asinus	7,8	no	no	yes	yes
Human	Homo sapiens	7	no	no	yes	yes
Birds of the Jemez Mountains and Wetlands						
Eared Grebe	Podiceps nigricollis	13	no	yes	yes	no
Pied-billed Grebe	Podilymbus podiceps	13	no	yes	yes	no
American Bittern	Botaurus lentiginosus	11,13	no	yes	yes	no
Great Blue Heron	Ardea herodias	6,14	no	yes	yes	no
Black-crowned Night Heron	Nycticorax nycticorax	11,13	no	yes	yes	no

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COMMON NAME	SCIENTIFIC NAME	Source <sup>1</sup>	GUILD <sup>2</sup>			
			Fully Aquatic	Semi-aquatic	Riparian	Terrestrial
Turkey Vulture	<i>Cathartes aura</i>	6, 10	no	no	yes	yes
Canada Goose	<i>Branta canadensis</i>	13	no	yes	yes	no
Wood Duck	<i>Aix sponsa</i>	13	no	yes	yes	no
Gadwall	<i>Anas strepera</i>	13,14	no	yes	yes	no
American Wigeon	<i>Anas americana</i>	13,14	no	yes	yes	no
Mallard	<i>Anas platyrhynchos</i>	6, 10,14	no	yes	yes	no
Blue-winged Teal	<i>Anas discors</i>	13,14	no	yes	yes	no
Green-winged Teal	<i>Anas crecca</i>	13,14	no	yes	yes	no
Cinnamon Teal	<i>Anas cyanoptera</i>	13,14	no	yes	yes	no
Northern Shoveler	<i>Anas clypeata</i>	13,14	no	yes	yes	no
Northern Pintail	<i>Anas acuta</i>	13,14	no	yes	yes	no
Ring-necked Duck	<i>Aythya collaris</i>	13,14	no	yes	yes	no
Lesser Scaup	<i>Aythya affinis</i>	13,14	no	yes	yes	no
Bufflehead	<i>Bucephala albeola</i>	13,14	no	yes	yes	no
Common Goldeneye	<i>Bucephala clangula</i>	13,14	no	yes	yes	no
Hooded Merganser	<i>Lophodytes cucullatus</i>	14	no	yes	yes	no
Common Merganser	<i>Mergus merganser</i>	6	no	yes	yes	no
Osprey	<i>Pandion haliaetus</i>	13,14	no	yes	yes	no
Bald Eagle	<i>Haliaeetus leucocephalus</i>	6,14	no	yes	yes	no
Northern Harrier	<i>Circus cyaneus hudsonius</i>	13,14	no	no	yes	yes
Sharp-shinned hawk	<i>Accipiter striatus</i>	10,14	no	no	yes	yes
Cooper's hawk	<i>Accipiter cooperii</i>	10,12, 14	no	no	yes	yes
Northern goshawk	<i>Accipiter gentilis</i>	10,14	no	no	yes	yes
Swainson's Hawk	<i>Buteo swainsoni</i>	13,14	no	no	yes	yes
Zone-tailed Hawk	<i>Buteo albonotatus</i>	10,13,14	no	no	no	yes
Red-tailed Hawk	<i>Buteo jamaicensis</i>	6, 10,13,14	no	no	no	yes
Ferruginous Hawk	<i>Buteo regalis</i>	13	no	no	no	yes
Rough-legged Hawk	<i>Buteo lagopus</i>	13	no	no	yes	yes
Golden Eagle	<i>Aquila chrysaetos</i>	6,13,14	no	no	no	yes
American Kestrel	<i>Falco sparverius</i>	6, 10,14	no	no	yes	yes
Merlin	<i>Falco columbarius</i>	11, 14	no	no	no	yes
Prairie Falcon	<i>Falco mexicanus</i>	14	no	no	no	yes
American Peregrine Falcon	<i>Falco peregrinus</i>	10	no	no	yes	yes
Blue Grouse	<i>Dendragapus obscurus</i>	10	no	no	no	yes
Wild Turkey	<i>Meleagris gallopavo</i>	10	no	no	yes	no
Scaled Quail	<i>Callipepla squamata</i>	6,13	no	no	no	yes
Gambel's Quail	<i>Callipepla gambelii</i>	10, 13	no	no	no	yes
American Coot	<i>Fulica americana</i>	6,14	no	yes	yes	no
Sandhill Crane	<i>Grus canadensis</i>	14	no	yes	yes	no
Killdeer	<i>Charadrius vociferus</i>	13	no	yes	yes	no
Mountain Plover	<i>Charadrius montanus</i>	13	no	no	yes	yes
Spotted Sandpiper	<i>Actitis macularia</i>	10, 13	no	yes	yes	no
Ring-billed Gull	<i>Larus delawarensis</i>	14	no	no	yes	yes
Rock Dove	<i>Columba livia</i>	13	no	no	no	yes
Band-tailed Pigeon	<i>Columba fasciata</i>	6	no	no	no	yes
Mourning Dove	<i>Zenaidura macroura</i>	6, 12	no	no	yes	no
Greater Roadrunner	<i>Geococcyx californianus</i>	14	no	no	yes	yes
Barn Owl	<i>Tyto alba</i>	13	no	no	yes	yes
Flammulated Owl	<i>Otus flammeolus</i>	6, 10	no	no	no	yes

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COMMON NAME	SCIENTIFIC NAME	Source <sup>1</sup>	GUILD <sup>2</sup>			
			Fully Aquatic	Semi-aquatic	Riparian	Terrestrial
Western Screech Owl	Otus kennicottii	6	no	no	no	yes
Great-horned Owl	Bubo virginianus	10, 13	no	no	no	yes
Northern Pygmy Owl	Glaucidium gnoma	10	no	no	no	yes
Mexican Spotted Owl	Strix occidentalis lucida	6, 10	no	no	no	yes
Northern Saw-whet Owl	Aegolius acadicus	10, 13	no	no	yes	yes
Common Nighthawk	Chordeiles minor	10	no	no	no	yes
Common Poorwill	Phalaenoptilus nuttalli	10	no	no	no	yes
Whip-poor-will	Caprimulgus vociferus	6, 13	no	no	no	yes
White-throated swift	Aeronautes saxatalis	6, 10, 13	no	no	yes	yes
Black-chinned Hummingbird	Archilochus alexandri	6, 10, 13	no	no	yes	no
Calliope Hummingbird	Stellula calliope	14	no	no	no	yes
Broad-tailed Hummingbird	Selasphorus platycercus	6, 10, 11	no	no	no	yes
Rufous Hummingbird	Selasphorus rufus	14	no	no	yes	yes
Belted Kingfisher	Ceryle alcyon	13	no	yes	yes	no
Lewis's Woodpecker	Melanerpes lewis	6	no	no	yes	no
Acorn Woodpecker	Melanerpes formicivorus	6, 10	no	no	no	yes
Yellow-bellied Sapsucker	Sphyrapicus varius varius	6	no	no	yes	no
Red-naped Sapsucker	Sphyrapicus nuchalis	10	no	no	yes	yes
Williamson's Sapsucker	Sphyrapicus thyroideus	10	no	no	no	yes
Ladder-backed Woodpecker	Picoides scalaris	10	no	no	yes	no
Downy Woodpecker	Picoides pubescens	10	no	no	no	yes
Hairy Woodpecker	Picoides villosus	6, 10, 11, 12	no	no	no	yes
Three-toed Woodpecker	Picoides tridactylus	10, 12	no	no	no	yes
Northern Flicker	Colaptes auratus	6, 10, 12, 13	no	no	yes	yes
Olive-sided Flycatcher	Contopus cooperi	13	no	no	yes	yes
Western Wood-Pewee	Contopus sordidulus	6, 10, 12	no	no	yes	yes
Willow Flycatcher	Empidonax traillii	6	no	no	yes	yes
Hammond's Flycatcher	Empidonax hammondii	10, 12	no	no	no	yes
Dusky Flycatcher	Empidonax oberholseri	10	no	no	no	yes
Gray Flycatcher	Empidonax wrightii	6, 10	no	no	no	yes
Cordilleran Flycatcher	Empidonax occidentalis	10, 12	no	no	yes	yes
Black Phoebe	Sayornis nigricans semiatra	10	no	no	yes	yes
Say's Phoebe	Sayornis saya	6, 10	no	no	yes	no
Ash-throated Flycatcher	Myiarchus cinerascens	10, 12	no	no	yes	no
Western Kingbird	Tyrannus verticalis	13	no	no	yes	no
Cassin's Kingbird	Tyrannus vociferans	6, 10	no	no	yes	no
Loggerhead Shrike	Lanius ludovicianus	13	no	no	yes	no
Gray Vireo	Vireo vicinior	13	no	no	no	yes
Solitary Vireo	Vireo solitarius	6, 10, 12	no	no	yes	yes
Warbling Vireo	Vireo gilvus	10, 12	no	no	yes	no
Gray Jay	Perisoreus canadensis	10	no	no	no	yes
Steller's Jay	Cyanocitta stelleri	6, 10, 12	no	no	no	yes
Western Scrub Jay	Aphelocoma californica	6, 10, 13	no	no	no	yes
Pinon Jay	Gymnorhinus cyanocephalus	10, 11	no	no	no	yes
Clark's Nutcracker	Nucifraga columbiana	6, 10	no	no	no	yes
Black-billed Magpie	Pica pica hudsonia	6, 10	no	no	no	yes
American Crow	Corvus brachyrhynchos	10	no	no	yes	no
Chihuahuan raven	Corvus cryptoleucus	6	no	no	no	yes
Common Raven	Corvus corax sinuatus	6, 10, 13	no	no	no	no

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COMMON NAME	SCIENTIFIC NAME	Source <sup>1</sup>	GUILD <sup>2</sup>			
			Fully Aquatic	Semi-aquatic	Riparian	Terrestrial
Horned Lark	<i>Eremophila alpestris</i>	13	no	no	no	yes
Tree Swallow	<i>Tachycineta bicolor</i>	14	no	no	yes	no
Violet-green Swallow	<i>Tachycineta thalassina</i>	10, 14	no	no	yes	yes
N. Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	14	no	no	yes	no
Bank Swallow	<i>Riparia riparia</i>	14	no	no	yes	no
Barn Swallow	<i>Hirundo rustica</i>	14	no	no	yes	yes
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>	10	no	no	yes	yes
Black-capped Chickadee	<i>Poecile atricapillus</i>	13	no	no	yes	yes
Mountain Chickadee	<i>Poecile gambeli</i>	6, 10, 12	no	no	no	yes
Juniper ("Plain") Titmouse	<i>Baeolophus ridgwayi</i>	6, 10	no	no	yes	yes
Bushtit	<i>Psaltirparus minimus</i>	10, 5	no	no	yes	no
Red-breasted Nuthatch	<i>Sitta canadensis</i>	10	no	no	no	yes
White-breasted Nuthatch	<i>Sitta carolinensis</i>	10, 12, 14	no	no	no	yes
Pygmy Nuthatch	<i>Sitta pygmaea</i>	6, 10, 12	no	no	no	yes
Brown Creeper	<i>Certhia americana</i>	13, 14	no	no	yes	yes
Rock Wren	<i>Salpinctes obsoletus</i>	10, 12, 14	no	no	no	yes
Canyon Wren	<i>Catherpes mexicanus</i>	10, 12, 13	no	no	no	yes
Bewick's Wren	<i>Thryomanes bewickii</i>	10	no	no	yes	yes
House Wren	<i>Troglodytes aedon</i>	6, 10, 12	no	no	yes	yes
American Dipper	<i>Cinclus mexicanus</i>	10, 11, 13	no	yes	yes	no
Golden-crowned Kinglet	<i>Regulus satrapa</i>	6	no	no	yes	yes
Ruby-crowned Kinglet	<i>Regulus calendula</i>	10	no	no	yes	no
Blue-gray Gnatcatcher	<i>Polioptila caerulea</i>	10, 12	no	no	yes	yes
Western Bluebird	<i>Sialia mexicana</i>	6, 10, 14	no	no	yes	no
Mountain Bluebird	<i>Sialia currucoides</i>	6, 10, 14	no	no	no	no
Townsend's Solitaire	<i>Myadestes townsendi</i>	6, 10, 14	no	no	yes	yes
Hermit Thrush	<i>Catharus guttatus</i>	10, 12, 13	no	no	no	no
American Robin	<i>Turdus migratorius</i>	6, 10, 12	no	no	yes	no
Gray Catbird	<i>Dumetella carolinensis</i>	13	no	no	no	yes
Northern Mockingbird	<i>Mimus polyglottos</i>	10	no	no	yes	no
European Starling	<i>Sturnus vulgaris</i>	6	no	no	yes	no
American Pipit	<i>Anthus rubescens</i>	13	no	no	no	yes
Orange-crowned Warbler	<i>Vermivora celata</i>	10, 11	no	no	no	yes
Virginia's Warbler	<i>Vermivora virginiae</i>	10, 11	no	no	yes	yes
Yellow Warbler	<i>Dendroica petechia</i>	6	no	no	yes	yes
Yellow-rumped Warbler	<i>Dendroica coronata</i>	6, 10, 12	no	no	yes	no
Black-throated Gray Warbler	<i>Dendroica nigrescens</i>	10	no	no	no	yes
Townsend's Warbler	<i>Dendroica townsendi</i>	13	no	no	yes	yes
Grace's Warbler	<i>Dendroica graciae</i>	10, 12	no	no	no	yes
Macgillivray's Warbler	<i>Oporornis tolmiei</i>	10	no	no	no	yes
Common Yellowthroat	<i>Geothlypis trichas</i>	13	no	no	yes	no
Wilson's Warbler	<i>Wilsonia pusilla</i>	6	no	no	no	yes
Yellow-breasted Chat	<i>Icteria virens</i>	13	no	no	yes	no
Hepatic Tanager	<i>Piranga flava</i>	10	no	no	yes	yes
Summer Tanager	<i>Piranga rubra</i>	13	no	no	yes	no
Western Tanager	<i>Piranga ludoviciana</i>	6, 10	no	no	yes	no
Green-tailed Towhee	<i>Pipilo chlorurus</i>	10, 14	no	no	yes	no
Canyon Towhee	<i>Pipilo fuscus</i>	6, 10	no	no	no	yes
Spotted Towhee	<i>Pipilo maculatus</i>	6, 10	no	no	no	yes

**Table 2.** Wildlife Species Reported in the Jemez Mountains and Characterized by Life Cycle Dependency in Water ~ Continued.

COMMON NAME	SCIENTIFIC NAME	Source <sup>1</sup>	GUILD <sup>2</sup>			
			Fully Aquatic	Semi-aquatic	Riparian	Terrestrial
Cassin's Sparrow	<i>Aimophila cassinii</i>	13	no	no	no	yes
Rufous-crowned Sparrow	<i>Aimophila ruficeps</i>	10, 13	no	no	no	yes
Chipping Sparrow	<i>Spizella passerina</i>	6, 10, 14	no	no	yes	no
Brewer's Sparrow	<i>Spizella breweri</i>	13	no	no	yes	no
Black-chinned sparrow	<i>Spizella atrogularis</i>	6	no	no	no	yes
Vesper Sparrow	<i>Poocetes gramineus</i>	10	no	no	no	yes
Lark Sparrow	<i>Chondestes grammacus</i>	6, 10, 12, 13	no	no	yes	no
Black-throated Sparrow	<i>Amphispiza bilineata</i>	13	no	no	yes	no
Sage Sparrow	<i>Amphispiza belli</i>	13	no	no	yes	no
Savannah Sparrow	<i>Passerculus sandwichensis</i>	14	no	no	yes	no
Fox Sparrow	<i>Passerella iliaca</i>	13	no	no	no	yes
Song Sparrow	<i>Melospiza melodia</i>	10	no	no	yes	no
Lincoln's Sparrow	<i>Melospiza lincolni</i>	10	no	no	yes	no
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	6	no	no	yes	no
Dark-eyed Junco	<i>Junco hyemalis</i>	6, 10	no	no	yes	no
Black-headed Grosbeak	<i>Pheucticus melanocephalus</i>	14	no	no	yes	no
Blue Grosbeak	<i>Guiraca caerulea</i>	14	no	no	no	yes
Lazuli Bunting	<i>Passerina amoena</i>	10	no	no	yes	no
Indigo Bunting	<i>Passerina cyanea</i>	10	no	no	no	yes
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	10, 13	no	no	yes	no
Western Meadowlark	<i>Sturnella neglecta</i>	10	no	no	no	yes
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>	10	no	no	yes	no
Great-tailed Grackle	<i>Quiscalus mexicanus</i>	6	no	no	yes	no
Brown-headed Cowbird	<i>Molothrus ater</i>	10	no	no	yes	no
Bullock's Oriole	<i>Icterus bullockii</i>	10	no	no	no	yes
Scott's Oriole	<i>Icterus parisorum</i>	10	no	no	yes	no
Pine Grosbeak	<i>Pinicola enucleator</i>	13	no	no	no	yes
Cassin's Finch	<i>Carpodacus cassinii</i>	6, 13	no	no	yes	yes
House Finch	<i>Carpodacus mexicanus</i>	6, 12	no	no	yes	no
Red Crossbill	<i>Loxia curvirostra</i>	6, 10, 12	no	no	no	yes
Pine Siskin	<i>Carduelis pinus pinus</i>	10, 12, 13	no	no	yes	yes
Lesser Goldfinch	<i>Carduelis psaltria</i>	10, 12, 13	no	no	yes	no
American Goldfinch	<i>Carduelis tristis pallidus</i>	13	no	no	yes	no
Evening Grosbeak	<i>Coccothraustes vespertinus</i>	10, 13	no	no	no	yes
House Sparrow	<i>Passer domesticus</i>	10	no	no	yes	no
**Aquatic Invertebrates of the Los Alamos, Sandia, Valle, and Pajarito Canyons are listed in Appendix III. Over 250 aquatic invertebrate taxa were reported in canyon streams on the Pajarito Plateau by Cross 1997.						

<sup>1</sup> Source:

- 1 Sublette *et al.* 1990
- 2 Calamusso and Rinne 1999
- 3 Rinne and Platania 1995
- 4 Degenhardt *et al.* 1996
- 5 Foxx *et al.* 1999
- 6 Hinojosa 1997
- 7 Findley *et al.* 1975
- 8 Biggs *et al.* 1997b
- 9 Biggs *et al.* 1997a
- 10 Travis 1992
- 11 Poole and Gill 1999
- 12 Johnson and Wauer 1996
- 13 National Geographic Society 1987
- 14 Fettig 1999



**Table 2. Wildlife Species Reported in the Jemez Mountains and Characterized by Life Cycle Dependency in Water ~ Continued.**

COMMON NAME	SCIENTIFIC NAME	Source <sup>1</sup>	GUILD <sup>2</sup>			
			Fully Aquatic	Semi-aquatic	Riparian	Terrestrial

<sup>2</sup> Guild = Wildlife species were associated with a habitat classified as fully aquatic, semi-aquatic, riparian, or terrestrial according to NMDGF 1998, Short 1983, and Niering 1985.

**Table 3. Watershed Characteristics of Canyons that Contain the Stream Segments Studied For the LANL Water Quality Assessment, 1996-1997.**

Variable	Canyon Watershed or Drainage				
	Los Alamos	Sandia	Pajarito	Water <sup>a</sup>	Valle
Drainage Area (km <sup>2</sup> )	28.4	14.2	20.7	15.4	10.8
Basin Length (km)	25.9	15.8	22.5	21.7	11.9
Stream Order at Mouth	3	2	3	3	2
Stream Order at Study Site	2	2 <sup>b</sup>	2	--	2
Vegetation <sup>c</sup> and Land Use					--
% Spruce/Fir	38.8	1.2	25.4	26.4	--
% Aspen	4.1	<0.1	2.7	3.1	--
% Ponderosa Pine	14.8	13.2	33.8	37.6	--
% Piñon/Juniper and Juniper Savannah	24.7	59.8	16.3	23.1	--
% Grassland	2.3	3.2	3.9	6.5	--
% Unvegetated	9.6	13.1	3.4	2.5	--
% Developed	4.9	9.5	15.3	0.6	--

<sup>a</sup> Land use data only available for Water Canyon, which contains Valle Canyon.

<sup>b</sup> Stream order determined from topographic maps indicated a first order stream at the study location, however, effluent discharges that are similar to tributaries in volume and location indicated a second order stream.

<sup>c</sup> Based on the preliminary vegetation and land cover classification for the Los Alamos National Laboratory and vicinity as reported by Koch *et al.* (1997).

**Table 4.** Location of Cages, Hydrolab Monitoring, and Habitat Measurements in Canyon Stream Reaches for the LANL Water Quality Assessment, 1996-1997.

Canyon Stream Reach	Cage Number, Monitoring, or Habitat Measurement	X - Y Coordinates	
		Easting	Northing
Los Alamos AR <sup>a</sup>	Hydrolab monitoring	377385	3971927
Sandia Canyon	Hydrolab monitoring	381852	3970414
Pajarito Canyon	Hydrolab monitoring	379362	3968959
Valle Canyon	Hydrolab monitoring	379703	3967945
Los Alamos AR	Cages T1 <sup>b</sup> and B1 <sup>c</sup>	377230	3972135
Los Alamos AR	Cages T2 and B2	377262	3972104
Los Alamos AR	Cages T3 and B3	377286	3972095
Los Alamos AR	Cages T4 and B4	377310	3972058
Los Alamos AR	Cages T5 and B5	377332	3972024
Los Alamos AR	Cages T6 and B6	377336	3972009
Los Alamos AR	Cages T7 and B7	377341	3971986
Los Alamos AR	Cages T8 and B8	377353	3971958
Los Alamos AR	Cages T9 and B9	377385	3971927
Sandia Canyon	Cages T1 and B1	381852	3970414
Sandia Canyon	Cages T2 and B2	381894	3970414
Sandia Canyon	Cages T3 and B3	381943	3970388
Sandia Canyon	Cages T4 and B4	381967	3970386
Sandia Canyon	Cages T5 and B5	381997	3970372
Sandia Canyon	Cages T6 and B6	382052	3970367
Sandia Canyon	Cages T7 and B7	382079	3970352
Sandia Canyon	Cages T8 and B8	382007	3970337
Sandia Canyon	Cages T9 and B9	382048	3970348
Pajarito Canyon	Cages T1 and B1	379362	3968959

**Table 4.** Location of Cages and Habitat Measurements in Canyon Stream Reaches for the LANL Water Quality Assessment, 1996-1997. ~ *Continued.*

Pajarito Canyon	Cages T2 and B2	379409	3968940
Pajarito Canyon	Cages T3 and B3	379446	3968926
Pajarito Canyon	Cages T4 and B4	379475	3968950
Pajarito Canyon	Cages T5 and B5	379508	3968925
Pajarito Canyon	Cages T6 and B6	379531	3968916
Pajarito Canyon	Cages T7 and B7	379566	3968911
Pajarito Canyon	Cages T8 and B8	379589	3968907
Pajarito Canyon	Cages T9 and B9	379601	3968885
Valle Canyon	Cages T1 and B1	379703	3967945
Valle Canyon	Cages T2 and B2	379736	3967982
Valle Canyon	Cages T3 and B3	379773	3968004
Valle Canyon	Cages T4 and B4	379800	3968018
Valle Canyon	Cages T5 and B5	379826	3968033
Valle Canyon	Cages T6 and B6	379860	3968030
Valle Canyon	Cages T7 and B7	379895	3968033
Valle Canyon	Cages T8 and B8	379914	3968025
Valle Canyon	Cages T9 and B9	379971	3968045
Los Alamos AR	Upper Habitat Transect 1	377188	3972147
Los Alamos AR	Upper Habitat Transect 2	377188	3972143
Los Alamos AR	Upper Habitat Transect 3	377197	3972138
Los Alamos AR	Upper Habitat Transect 4	377213	3972124
Los Alamos AR	Upper Habitat Transect 5	377221	3972131
Los Alamos AR	Upper Habitat Transect 6	377233	3972131
Los Alamos AR	Upper Habitat Transect 7	377246	3972123
Los Alamos AR	Upper Habitat Transect 8	377256	3972115
Los Alamos AR	Upper Habitat Transect 9	377261	3972115

**Table 4.** Location of Cages and Habitat Measurements in Canyon Stream Reaches for the LANL Water Quality Assessment, 1996-1997. ~ *Continued.*

Los Alamos AR	Upper Habitat Transect 10	377262	3972104
Los Alamos AR	Lower Habitat Transect 1	377312	3972048
Los Alamos AR	Lower Habitat Transect 2	377317	3972045
Los Alamos AR	Lower Habitat Transect 3	377319	3972029
Los Alamos AR	Lower Habitat Transect 4	377321	3972019
Los Alamos AR	Lower Habitat Transect 5	377332	3972024
Los Alamos AR	Lower Habitat Transect 6	377332	3972008
Los Alamos AR	Lower Habitat Transect 7	377343	3971998
Los Alamos AR	Lower Habitat Transect 8	377338	3971988
Los Alamos AR	Lower Habitat Transect 9	377339	3971987
Los Alamos AR	Lower Habitat Transect 10	377334	3971971
Los Alamos BR <sup>d</sup>	Habitat Transect 1	378133	3971548
Los Alamos BR	Habitat Transect 2	378134	3971536
Los Alamos BR	Habitat Transect 3	378142	3971533
Los Alamos BR	Habitat Transect 4	378159	3971542
Los Alamos BR	Habitat Transect 5	378165	3971535
Los Alamos BR	Habitat Transect 6	378174	3971533
Los Alamos BR	Habitat Transect 7	378183	3971532
Los Alamos BR	Habitat Transect 8	378184	3971528
Los Alamos BR	Habitat Transect 9	378194	3971534
Los Alamos BR	Habitat Transect 10	378201	3971520
Sandia Canyon	Upper Habitat Transect 1	381895	3970407
Sandia Canyon	Upper Habitat Transect 2	381909	3970407
Sandia Canyon	Upper Habitat Transect 3	381911	3970406
Sandia Canyon	Upper Habitat Transect 4	381920	3970404
Sandia Canyon	Upper Habitat Transect 5	381931	3970392

**Table 4.** Location of Cages and Habitat Measurements in Canyon Stream Reaches for the LANL Water Quality Assessment, 1996-1997. ~ *Continued.*

Sandia Canyon	Upper Habitat Transect 6	381935	3970390
Sandia Canyon	Upper Habitat Transect 7	381945	3970390
Sandia Canyon	Upper Habitat Transect 8	381956	3970388
Sandia Canyon	Upper Habitat Transect 9	381963	3970386
Sandia Canyon	Upper Habitat Transect 10	381973	3970373
Sandia Canyon	Lower Habitat Transect 1	382083	3970352
Sandia Canyon	Lower Habitat Transect 2	382093	3970352
Sandia Canyon	Lower Habitat Transect 3	382101	3970343
Sandia Canyon	Lower Habitat Transect 4	382105	3970340
Sandia Canyon	Lower Habitat Transect 5	382110	3970338
Sandia Canyon	Lower Habitat Transect 6	382121	3970343
Sandia Canyon	Lower Habitat Transect 7	382129	3970345
Sandia Canyon	Lower Habitat Transect 8	382139	3970344
Sandia Canyon	Lower Habitat Transect 9	382148	3970343
Sandia Canyon	Lower Habitat Transect 10	382158	3970338
Pajarito Canyon	Upper Habitat Transect 1	379367	3968954
Pajarito Canyon	Upper Habitat Transect 2	379375	3968954
Pajarito Canyon	Upper Habitat Transect 3	379384	3968950
Pajarito Canyon	Upper Habitat Transect 4	379393	3968945
Pajarito Canyon	Upper Habitat Transect 5	379401	3968942
Pajarito Canyon	Upper Habitat Transect 6	379405	3968916
Pajarito Canyon	Upper Habitat Transect 7	379421	3968932
Pajarito Canyon	Upper Habitat Transect 8	379427	3968929
Pajarito Canyon	Upper Habitat Transect 9	379430	3968924
Pajarito Canyon	Upper Habitat Transect 10	379445	3968941
Pajarito Canyon	Lower Habitat Transect 1		

**Table 4.** Location of Cages and Habitat Measurements in Canyon Stream Reaches for the LANL Water Quality Assessment, 1996-1997. ~ *Continued.*

Pajarito Canyon	Lower Habitat Transect 2		
Pajarito Canyon	Lower Habitat Transect 3		
Pajarito Canyon	Lower Habitat Transect 4		
Pajarito Canyon	Lower Habitat Transect 5		
Pajarito Canyon	Lower Habitat Transect 6		
Pajarito Canyon	Lower Habitat Transect 7		
Pajarito Canyon	Lower Habitat Transect 8		
Pajarito Canyon	Lower Habitat Transect 9		
Pajarito Canyon	Lower Habitat Transect 10		
Valle Canyon	Upper Habitat Transect 1	379737	3967981
Valle Canyon	Upper Habitat Transect 2	379740	3967990
Valle Canyon	Upper Habitat Transect 3	379757	3967988
Valle Canyon	Upper Habitat Transect 4	379761	3967994
Valle Canyon	Upper Habitat Transect 5	379769	3968001
Valle Canyon	Upper Habitat Transect 6	379773	3968001
Valle Canyon	Upper Habitat Transect 7	379784	3968028
Valle Canyon	Upper Habitat Transect 8	379895	3968012
Valle Canyon	Upper Habitat Transect 9	379806	3968009
Valle Canyon	Upper Habitat Transect 10	379813	3968007
Valle Canyon	Lower Habitat Transect 1	379994	3968015
Valle Canyon	Lower Habitat Transect 2	380002	3968014
Valle Canyon	Lower Habitat Transect 3	380011	3968024
Valle Canyon	Lower Habitat Transect 4	380013	3968010
Valle Canyon	Lower Habitat Transect 5	380026	3968016
Valle Canyon	Lower Habitat Transect 6	380036	3968012
Valle Canyon	Lower Habitat Transect 7	380040	3968027

**Table 4.** Location of Cages and Habitat Measurements in Canyon Stream Reaches for the LANL Water Quality Assessment, 1996-1997. ~ *Continued.*

Valle Canyon	Lower Habitat Transect 8	380051	3968023
Valle Canyon	Lower Habitat Transect 9	380053	3968021
Valle Canyon	Lower Habitat Transect 10	380055	3968012

<sup>a</sup> AR = above the Los Alamos Reservoir.

<sup>b</sup> T1 = Toxicity Cage 1, and so on. See text.

<sup>c</sup> B1 = Bioaccumulation Cage 1, and so on. See text.

<sup>d</sup> BR = below the Los Alamos Reservoir.



**Table 5.** Chemical Name, Symbol, Method of Analysis, and Reporting Limits for the LANL Water Quality Assessment, 1996-1997.

Chemical Name	Symbol	Method	Reporting Limits <sup>a</sup>			
			water	pore water	sediment	tissue
<i>Elements</i>			µg/L	µg/L	mg/kg DW <sup>b</sup>	mg/kg DW
aluminum	Al	ICP-MS <sup>c</sup>	0.01	0.01	1	— <sup>d</sup>
aluminum	Al	ICP/AES <sup>e</sup>	21.5	21.5	5	2
antimony	Sb	ICP-MS	0.001	0.001	0.1	---
arsenic	As	ICP-MS	0.01	0.01	1	---
arsenic	As	ICP/AES	21.5	21.5	1.6	1.5
barium	Ba	ICP-MS	0.001	0.001	0.1	---
barium	Ba	ICP/AES	0.8	0.8	0.1	0.1
beryllium	Be	ICP/AES	0.3	0.3	0.2	0.02
boron	B	ICP/AES	19.3	19.3	0.2	3
cadmium	Cd	ICP-MS	0.01	0.01	1	---
cadmium	Cd	ICP/AES	1.5	1.5	0.2	0.01
calcium	Ca	ICP-MS	0.01	0.01	1	---
cerium	Ce	ICP-MS	0.001	0.001	0.1	---
cesium	Cs	ICP-MS	0.001	0.001	0.1	---
chromium	Cr	ICP-MS	0.01	0.01	1	---
chromium	Cr	ICP/AES	2.5	2.5	0.4	0.5
cobalt	Co	ICP-MS	0.01	0.01	1	---
copper	Cu	ICP-MS	0.01	0.01	1	---
copper	Cu	ICP/AES	2.2	2.2	0.3	0.5
dysprosium	Dy	ICP-MS	0.001	0.001	0.1	---
erbium	Er	ICP-MS	0.001	0.001	0.1	---
europium	Eu	ICP-MS	0.001	0.001	0.1	---
gadolinium	Gd	ICP-MS	0.001	0.001	0.1	—
gallium	Ga	ICP-MS	0.01	0.01	1	---
germanium	Ge	ICP-MS	0.01	0.01	1	---

**Table 5.** Chemical Name, Symbol, Method of Analysis, and Reporting Limits for the Los Alamos National Laboratory Use Study, 1996-1997 ~ *Continued.*

Chemical Name	Symbol	Method	Reporting Limits			
			water	pore water	sediment	tissue
gold	Au	ICP-MS	0.001	0.001	0.1	---
hafnium	Hf	ICP-MS	0.001	0.001	0.1	---
holmium	Ho	ICP-MS	0.001	0.001	0.1	---
indium	In	ICP-MS	0.001	0.001	0.1	---
iridium	Ir	ICP-MS	0.001	0.001	0.1	---
iron	Fe	ICP-MS	0.01	0.01	1	---
iron	Fe	ICP/AES	2.6	2.6	8.1	5
lanthanum	La	ICP-MS	0.001	0.001	0.1	---
lead	Pb	ICP-MS	0.001	0.001	0.1	---
lead	Pb	ICP/AES	15.9	15.9	1.4	4
lithium	Li	ICP-MS	0.01	0.01	1	---
lutetium	Lu	ICP-MS	0.001	0.001	0.1	---
magnesium	Mg	ICP-MS	0.01	0.01	1	---
magnesium	Mg	ICP/AES	36.3	36.3	3.5	5
manganese	Mn	ICP-MS	0.01	0.01	1	---
manganese	Mn	ICP/AES	1.6	1.6	0.1	1
mercury	Hg	CVAA <sup>f</sup>	---	---	0.2	0.1
molybdenum	Mo	ICP-MS	0.001	0.001	0.1	---
molybdenum	Mo	ICP/AES	4.0	4.0	0.3	0.4
neodymium	Nd	ICP-MS	0.001	0.001	0.1	---
nickel	Ni	ICP-MS	0.01	0.01	1	---
nickel	Ni	ICP/AES	4.4	4.4	0.1	1
niobium	Nb	ICP-MS	0.001	0.001	0.1	---
osmium	Os	ICP-MS	0.001	0.001	0.1	---
palladium	Pd	ICP-MS	0.01	0.01	1	---
platinum	Pt	ICP-MS	0.001	0.001	0.1	---

**Table 5.** Chemical Name, Symbol, Method of Analysis, and Reporting Limits for the Los Alamos National Laboratory Use Study, 1996-1997 ~ *Continued.*

Chemical Name	Symbol	Method	Reporting Limits			
			water	pore water	sediment	tissue
potassium	K	ICP-MS	0.1	0.1	1	---
praseodymium	Pr	ICP-MS	0.001	0.001	0.1	---
rhenium	Re	ICP-MS	0.001	0.001	0.1	---
rubidium	Rb	ICP-MS	0.01	0.01	1	---
ruthenium	Ru	ICP-MS	0.001	0.001	0.1	---
samarium	Sm	ICP-MS	0.001	0.001	0.1	---
scandium	Sc	ICP-MS	0.01	0.01	1	---
selenium	Se	HGAA <sup>8</sup>	0.5	0.5	0.01	---
selenium	Se	HGAA	2.6	2.6	0.25	0.1
silver	Ag	ICP-MS	0.001	0.001	0.1	---
sodium	Na	ICP-MS	0.01	0.01	1	---
strontium	Sr	ICP-MS	0.01	0.01	1	---
strontium	Sr	ICP/AES	0.2	0.2	0.01	0.5
tantalum	Ta	ICP-MS	0.001	0.001	0.1	---
tellurium	Te	ICP-MS	0.01	0.01	1	---
terbium	Tb	ICP-MS	0.001	0.001	0.1	---
thallium	Tl	ICP-MS	0.001	0.001	0.1	---
thorium	Th	ICP-MS	0.001	0.001	0.1	---
thulium	Tm	ICP-MS	0.001	0.001	0.1	---
tin	Sn	ICP-MS	0.01	0.01	1	---
titanium	Ti	ICP-MS	0.01	0.01	1	---
tungsten	W	ICP-MS	0.001	0.001	0.1	---
uranium	U	ICP-MS	0.001	0.001	0.1	---
vanadium	V	ICP-MS	0.01	0.01	1	---
vanadium	V	ICP/AES	2.0	2.0	0.4	0.5
ytterbium	Yb	ICP-MS	0.001	0.001	0.1	---

**Table 5.** Chemical Name, Symbol, Method of Analysis, and Reporting Limits for the Los Alamos National Laboratory Use Study, 1996-1997 ~ *Continued.*

Chemical Name	Symbol	Method	Reporting Limits			
			water	pore water	sediment	tissue
yttrium	Y	ICP-MS	0.001	0.001	0.1	---
zinc	Zn	ICP-MS	0.01	0.01	1	---
zinc	Zn	ICP/AES	4.0	4.0	0.4	1.0
zirconium	Zr	ICP-MS	0.001	0.001	0.1	---
<b>Radionuclides and Radiochemical Activity</b>			pCi/L	pCi/L		
uranium-238	U <sup>238</sup>	GS <sup>h</sup>	0.03	0.02	---	---
uranium-235	U <sup>235</sup>	GS	0.04	0.03	---	---
uranium-234	U <sup>234</sup>	GS	0.04	0.03	---	---
thorium-232	Th <sup>232</sup>	GS	0.3	0.3	---	---
thorium-230	Th <sup>230</sup>	GS	0.4	0.3	---	---
thorium-228	Th <sup>228</sup>	GS	0.4	0.4	---	---
thorium-227	Th <sup>227</sup>	GS	0.4	0.4	---	---
radium-228	Ra <sup>228</sup>	GS	56	50	---	---
radium-226	Ra <sup>226</sup>	GS	260	260	---	---
barium-140	Ba <sup>140</sup>	GS	6200	5300	---	---
cesium-137	Cs <sup>137</sup>	GS	77	48	---	---
iodine-131	I <sup>131</sup>	GS	87000	46000	---	---
cobalt-60	Co <sup>60</sup>	GS	75	57	---	---
potassium-40	K <sup>40</sup>	GS	220	250	---	---
gross alpha	α	GS	64	55	---	---
gross beta	β	GS	72	71	---	---
<b>Explosives</b>			μg/L		μg/kg DW	
hexahydro-1,3,5-trinitro-1,3,5-triazine	RDX	HPLC/UV <sup>i</sup>	0.06	---	50	---

**Table 5.** Chemical Name, Symbol, Method of Analysis, and Reporting Limits for the Los Alamos National Laboratory Use Study, 1996-1997 ~ *Continued.*

Chemical Name	Symbol	Method	Reporting Limits			
			water	pore water	sediment	tissue
octahydro-1,3,5,7-teranitro-1,3,5,7-tetrazocine	HMX	HPLC/UV	0.06	---	50	---
1,3,5-trinitrobenzene	TNB	HPLC/UV	0.06	---	50	---
1,3-dinitrobenzene	DNB	HPLC/UV	0.06	---	50	---
tetryl	---	HPLC/UV	0.06	---	50	---
nitrobenze	NB	HPLC/UV	0.06	---	50	---
2,4,6-trinitrobenzene	TNT	HPLC/UV	0.06	---	50	---
2-amino-4,6-dinitrotoluene	2,4,6-DNT	HPLC/UV	0.06	---	50	---
4-amino-2,6-dinitrotoluene	4,2,6-DNT	HPLC/UV	0.06	---	50	---
2,4-dinitrotoluene	2,4-DNT	HPLC/UV	0.06	---	50	---
2,6-dinitrotoluene	2,6-DNT	HPLC/UV	0.06	---	50	---
2-nitrotoluene	2-NT	HPLC/UV	0.06	---	50	---
4-nitrotoluene	4-NT	HPLC/UV	0.06	---	50	---
3-nitrotoluene	3-NT	HPLC/UV	0.06	---	50	---
<b>Polychlorinated Biphenyls</b>					<b>µg/kg DW</b>	<b>µg/kg WW<sup>j</sup></b>
PCB congener	PCB	HP-GPC GC/ECD <sup>k</sup>	highest reporting limit of 129 congeners analyzed		1.1	7.5
total PCBs (sum of congeners)	ΣPCB	HP-GPC GC/ECD	highest reporting limit plus error		2.6	64.4
<div><sup>a</sup> Reporting Limit = Note that instrument and method detection limits may differ for the same analyte, depending on the laboratory method used, sample interference, <i>etc.</i> Laboratory reports were provided in Attachment A and may be consulted for method detection and reporting limits.</div> <div><sup>b</sup> “DW” = dry weight</div> <div><sup>c</sup> Inductively coupled plasma - mass spectrometry</div> <div><sup>d</sup> “—” = not analyzed using this method</div> <div><sup>e</sup> Inductively coupled plasma/atomic absorption spectrometry (EPA Method 200.7)</div> <div><sup>f</sup> Cold vapor atomic absorption spectrometry</div> <div><sup>g</sup> Hydride generation atomic absorption spectrometry</div> <div><sup>h</sup> Gamma spectrometry</div> <div><sup>i</sup> High performance liquid chromatography/ultraviolet absorbance detection (EPA Method 8330)</div> <div><sup>j</sup> “WW” = wet weight</div> <div><sup>k</sup> High performance-gel permeation chromatography followed by gas chromatography/electron capture detection</div>						

**Table 6.** Sample, Preparation, Preservatives, Collection Containers, and Subsequent Analyses for the Los Alamos National Laboratory Use Study, 1996-1997.

Sample Type	Preparation	Preservative <sup>a</sup>	Container	Analyses
Water	none	none	none	field measurements <sup>b</sup>
Water	none	cold <sup>c</sup>	1 gallon, or 1 quart, cubitainer	lab measurements <sup>d</sup>
Water	none	cold/dark	1 L, amber, Boston round, glass jar	explosives <sup>e</sup>
Water	none	cold	1 gallon, or 1 quart cubitainer	field collection for below filtered-water analyses
Water	filtered though inline 0.45 µm	HNO <sub>3</sub>	500 mL, HDPE <sup>f</sup> , WM <sup>g</sup> Nalgene jar	trace elements <sup>h</sup> , radios <sup>i</sup>
Water	filtered though inline 0.45 µm	cold	500 mL, HDPE, WM Nalgene jar	chloride, sulfate, alkalinity, hardness
Water	filtered though inline 0.45 µm	H <sub>2</sub> SO <sub>4</sub>	250 mL, HDPE, WM Nalgene jar	nitrate-N, ammonia-N, ortho-phosphate
Sediment	debris removed	cold	500 mL, WM glass jar	trace elements, radios, acid volatile sulfides
Sediment	debris removed	cold	250 mL, WM glass jar	organic carbon, texture
Sediment	debris removed	cold/dark	500 mL, WM, foil-wrapped, glass jar	polychlorinated biphenyl congeners and explosives
Invertebrates	some had cases removed&rinsed	cold/frozen	7.5 x 19 cm, whirl-pak or food quality bags	trace elements
Fish	length and weight measured	cold/frozen	100 mL, WM glass jar	trace elements
Fish	length and weight measured	cold/frozen	100 mL, WM glass jar	polychlorinated biphenyl congeners
<sup>a</sup> Acid preservatives met USEPA purity standards. <sup>b</sup> Temperature, pH, dissolved oxygen, and conductivity. <sup>c</sup> Samples were kept on ice in the field, and then either transferred to a refrigerator (4 °C) or frozen. <sup>d</sup> Laboratory measurements included pH, temperature, total suspended solids and turbidity. <sup>e</sup> Explosives were RDX, HMX, TNT, DNT, and five major breakdown products (see Table 5). <sup>f</sup> HDPE = High density polyethylene plastic. <sup>g</sup> WM = wide-mouth. <sup>h</sup> Elements analyzed are listed in Table 5, also percent moisture was determined. <sup>i</sup> Radiochemical activity was analyzed on 1996 samples of water and sediment porewater only.				

**Table 7. Consensus-Based, Conservative Sediment Concentrations of Concern for the LANL Water Quality Assessment.**

Contaminant <sup>a</sup> (mg/kg DW)	Buchman <sup>b</sup>	Smith <sup>c</sup>	Ingersoll <sup>d</sup>	FDEP <sup>e</sup>	Long <sup>f</sup>	Persuad <sup>g</sup>	Anon <sup>h</sup>	EC & MENVIQ <sup>i</sup>	Sediment Concentration of Concern
Ag				0.7	1.0	0.5			1
Al	2600								2600
As	10.8	5.9	12.1	7.2	8.2	6.0	3.0	3.0	7
Ba							20		
Be									
B									
Cd	0.58	0.60	0.59	0.68	1.20	0.60	0.90	0.20	1
Cr	36.3	37.3	56.0	52.3	81.0	26.0	25.0	55.0	46
Cu	28.0	35.7	28.0	18.7	34.0	16.0	25.0	28.0	27
Fe						20000	21000		20500
Hg		0.0017		0.0001	0.0002	0.0002	0.0001	0.0002	0.0004
Mg									
Mn	615		1673			460	300		762
Mo									
Ni	19.5	18.0	39.6	15.9	20.9	16.0	20.0	35.0	23
Pb	34.2	35.0	34.2	30.2	46.7	31.0	40.0	23.0	34
Se									
Sr									
V									
Zn	94.2	123.1	159.0	124.0	150.0	120.0	145.0	150.0	133
PCBs	0.0316	0.0341	0.0316	0.0216	0.0227	0.0700		0.2000	0.06
DNB									
HMX									
RDX									
TNT									

<sup>a</sup> See Table 5 for chemical names and symbols<sup>b</sup> Buchman 1998.<sup>c</sup> Smith *et al.* 1996.<sup>d</sup> Ingersoll *et al.* 1996.<sup>e</sup> FDEP 1994.<sup>f</sup> Long and Morgan 1991.<sup>g</sup> Persuad *et al.* 1993.<sup>h</sup> Anonymous 1977.<sup>i</sup> EC and MENVIQ 1992.

**Table 8. Consensus-Based, Sediment Quality Criteria to Evaluate Sediment for the LANL Water Quality Assessment.**

Contaminant (mg/kg DW) <sup>a</sup>	Smith <sup>b</sup>	Ingersoll <sup>c</sup>	FDEP <sup>d</sup>	USEPA <sup>e</sup>	Long <sup>f</sup>	Persuad <sup>g</sup>	Anon <sup>h</sup>	EC & MENVIQ <sup>i</sup>	Talmadge <sup>j</sup>	Sediment Quality Criteria
Ag	1.8		1.8	3.7	3.7					2.7
Al		580300								580300
As	17.0	57.0	41.6	70.0	70.0	33.0	5.5	17.0		39
Ba							40			
Be										
B										
Cd	3.53	11.70	4.21	9.60	9.60	10.00	2.00	3.00		7
Cr	90.0	159.0	160.0	370.0	370.0	110.0	50.0	100.0		176
Cu	197.0	77.7	108.0	270.0	270.0	110.0	50.0	86.0		146
Fe						40000	25000			32500
Hg	0.0049		0.0007	0.0007	0.0007	0.0020	0.0010	0.0010		0.002
Mg										
Mn		1081				1110				1096
Mo										
Ni	35.9	38.5	42.8	52.0	51.6	75.0	50.0	61.0		51
Pb	91.3	396.0	112.0	218.0	218.0	250.0	60.0	170.0		189
Se										
Sr										
V										
Zn	315.0	1532.0	271.0	410.0	410.0	820.0	200.0	540.0		562
PCBs	0.2770	0.2447	0.1890	0.0025	0.1800	0.5300	1.0000			0.35
DNB									0.335	0.34
HMX									0.235	0.24
RDX									0.65	0.65
TNT									4.6	4.60

<sup>a</sup> All values are mg/kg dry weight. See Table 5 for chemical names and symbols, see text for method of SQC development.

<sup>b</sup> Smith *et al.* 1996.

<sup>c</sup> Ingersoll *et al.* 1996.

<sup>d</sup> FDEP 1994.

<sup>e</sup> USEPA 1997b.

<sup>f</sup> Long and Morgan 1991.

<sup>g</sup> Persuad *et al.* 1993.

<sup>h</sup> Anonymous 1977.

<sup>i</sup> EC and MENVIQ 1992.

<sup>j</sup> Talmadge *et al.* 1999.



**Table 9.** Major Stream Habitat Classification (Based on Meehan 1991).

<b>Habitat</b>	<b>Description</b>
Riffle	Shallow section of stream with rapid current and a water surface broken by gravel, rubble, or boulders.
Run	Swiftly flowing stream reach with little surface agitation and no major flow obstructions. A run often appears as a flooded riffle.
Glide	Slow, relatively shallow stream section with water velocities of 10 to 20 m <sup>3</sup> /s and little, or no, surface turbulence.
Pool	Portion of a stream with reduced water velocity, water depth greater than surrounding areas, water surface gradient at low flow often near zero and bed often concave in shape forming a depression in the profile of the thalweg.

**Table 10.** Pool Classification (Based on Hickman and Raleigh 1982; Hamilton and Bergersen 1984).

<b>Pool Class</b>	<b>Description</b>
1st class	Large and deep. Pool depth and size are sufficient to provide a low velocity resting area for several adult fish. More than 30 percent of the pool bottom is obscured due to depth, surface turbulence, or the presence of structures, for example, logs, debris, boulders, or overhanging banks and vegetation.
2nd class	Moderate size and depth. Pool depth and size are sufficient to provide a low velocity resting area for a few adult fish. From 5 to 30 percent of the pool bottom is obscured due to depth, surface turbulence, or structures.
3rd class	Small or shallow or both. Pool depth and size are sufficient to provide a low velocity resting area for one or two adult fish. Cover, if present, is in the form of shade, surface turbulence, or very limited structure. Typical third-class pools are wide, shallow pool areas of streams or small eddies behind boulders. Virtually the entire bottom are is discernable.

**Table 11.** Flow and Discharge Measurements (Recorded at Each Transect).

Variable	Description
Mean depth	Mean of the 5 to 10 depth measurements taken at each transect interval.
Thalweg depth	Thalweg depth. Mean of the five deepest, adjacent depth measurements.
Riffle depth	Calculated as mean depth measured at riffle habitats.
Flow	Velocity (V) in meters/second. Water flows were measured using a flow-meter and bulb, set to average readings over a 10-second interval. Measurements were taken at the midpoint between two adjacent transect depth measurements, and at approximately 0.6 of the water depth.
Riffle flow	Calculated by averaging flows determined at transects in riffle habitat.
Pool flow	Calculated by averaging flows determined at transects in pool habitat.
Calculated discharge	Calculated discharge (Q); $\sum$ (Width*Depth*Velocity) at each transect interval.
Measured discharge	Measured discharge (Q) m <sup>3</sup> /s, with 10 gallon bucket below culvert at Valle Canyon only.

**Table 12.** Bank Erosion Ratings (Based on Platts *et al.* 1983).

Rating	Rating Description
0	Stable. Not altered by water flows, animals, or people.
1 - 25	Slight alteration. Less than 25 percent of stream-bank is false*, broken down, or eroding.
26 - 50	Moderate alteration. Less than 50 percent of stream-bank is false, broken down, or eroding.
51 - 75	Major alteration. Greater than 50 percent of stream-bank is false, broken down, or eroding.
76 - 100	Severe alteration. Greater than 75 percent of stream-bank is false, broken down, or eroding.

\* False stream banks have been eroded away, and have receded back from the water's edge.

**Table 13. Bank Vegetative Stability Ratings (Based on Platts *et al.* 1983).**

<b>Rating</b>	<b>Rating Description</b>
4 (Excellent)	Greater than 80 percent of stream bank surfaces covered by healthy vegetation, and/or, were protected by boulders and rubble.
3 (Good)	50 to 79 percent of stream bank surfaces covered by healthy vegetation, and/or, were protected by gravel or larger material.
2 (Fair)	25 to 49 percent of stream bank surfaces covered by healthy vegetation, and/or, are protected by gravel or larger material.
1 (Poor)	Less than 25 percent of stream bank surfaces covered by healthy vegetation, was not protected from erosion, and banks were usually eroded each year.

**Table 14. Stream Bank Cover Ratings (Based on Platts *et al.* 1983).**

<b>Rating</b>	<b>Dominant Vegetation Rating Description</b>
4	Shrubs.
3	Trees.
2	Grasses and/or forbs.
1	Greater than 50 percent of stream bank transect intercepts had no vegetation, or dominant material was soil, rock, bridge materials, culverts, <i>etc.</i>

**Table 15. Classification of Substrate (Based on Lane 1947; and Platts *et al.* 1983).**

<b>Substrate Type</b>	<b>Size Range (mm)</b>
Boulder	> 256
Cobble	64 - 256
Gravel	2.0 - 64
Sand	0.062 - 2.0
Silt	0.004 - 0.062
Clay	< 0.004

**Table 16.** Embeddedness Ratings for Gravel, Rubble, and Boulders (Based on Platts *et al.* 1983).

<b>Rating</b>	<b>Rating Description</b>
5	Gravel, rubble, and boulder particles have less than 5 percent of their surface covered by fine sediment.
4	Gravel, rubble, and boulder particles have 5 to 25 percent of their surface covered by fine sediment.
3	Gravel, rubble, and boulder particles have 25 to 50 percent of their surface covered by fine sediment.
2	Gravel, rubble, and boulder particles have 50 to 75 percent of their surface covered by fine sediment.
1	Gravel, rubble, and boulder particles have more than 75 percent of their surface covered by fine sediment.

**Table 17. Parameters Measured to Assess Stream Geomorphic Characteristics.**

<b>Variable</b>	<b>Description</b>
Order	Stream order determined from USGS topographical maps.
Aspect	Stream aspect determined from upstream compass direction.
Elevation	Elevation at upstream end of the habitat reach determined from topographic maps.
Gradient	Percent channel slope measured with survey rod and scope level; calculated as elevation change divided by G.P.S.-determined down-valley length.
Meander length	Measured as straight distance between stream channel curves.
Sinuosity	Measured stream channel length divided by G.P.S.-determined down-valley length.
Habitat length	length (m) of riffles, glides, or pools.
Percent Pools	Percent Pools, categorized by pool quality- 1st, 2nd, or 3rd class; calculated as total length of pool sections/reach length.
Percent Riffles	Percent riffles, including runs and cascades; calculated as total length of riffle sections divided by the reach length.
Percent Pools/ Percent Riffles	Ratio of percent pools to percent riffles.
Belt width	Measured by sighting up and downstream at each transect, then measuring the total path width where the stream meanders.
Bank-full width	Width measured by visual inspection of immediate channel surroundings; corresponds to the width where the stream bank gradient levels out and/or there is other evidence of previous sustained water levels.
Stream width	Wetted-channel width measured at the edge of water at time of evaluation.
Mean depth	Depth across bank-full and wetted width transect lines. Ten equally spaced readings were taken for both bank-full and wetted widths. Bank-full depths were measured from a level string to the channel bottom, and wetted depths were measured from the water surface to the channel bottom.
Maximum depth	Mean maximum channel depth.

**Table 17.** Parameters Measured to Assess Stream Geomorphic Characteristics.~ *Continued.*

Width/Depth	Width to depth ratio. Calculated as bankfull width divided by mean water depth.
Riffle Length/ Width	Ratio of distance between riffle habitat and width.
D50	Dominant substrate material. Boulders, cobble, gravel, sand, silt, clay in pools and riffles were calculated from a plot of cumulative distribution of substrate size.
Bank Stability	Bank stability. Rating visually estimated, and scored according to Table 12.
Vegetation Stability	Bank vegetational stability rating. Visually estimated along a 1m-wide swath following the transect line, and scored at each transect according to Table 13.
Entrenchment	Calculated as bankfull width divided by maximum depth.

**Table 18.** Decision Matrix and Values Assigned to the Indices of Biological, Chemical, and Physical Quality using Comparison with the Reference Site and Comparison with Criteria (adapted from NMED 1998).

<u>Decision</u>	<u>Criteria for Decision</u>	<u>Value Assigned</u>
<b>INDEX OF BIOLOGICAL QUALITY:</b>		
<i>Indicators of Biological Diversity</i>		
Supported	# fish species > 80 % of reference site	5
Partially Supported	# fish species > 50-80 % of reference site	3
Not Supported	# fish species < 50 % of reference site	1
Supported	# shellfish species > 80 % of reference site	5
Partially Supported	# shellfish species > 50-80 % of reference site	3
Not Supported	# shellfish species < 50 % of reference site	1
Supported	# aquatic invertebrates > 80 % of reference site	5
Partially Supported	# aquatic invertebrates > 50-80% of reference site	3
Not Supported	# aquatic invertebrates < 50 % of reference site	1
Supported	Biological Condition > 80 % of reference site	5
Partially Supported	Biological Condition > 50-80 % of reference site	3
Not Supported	Biological Condition ≤ 50 % of reference site	1
<i>Indicators of water toxicity (laboratory test of surface water at 100 % dilution)</i>		
Supported	No chronic toxicity	5
Partially Supported	Chronic toxicity in 1 test	3
Not Supported	Any acute toxicity or chronic toxicity in > 1 test	1

**Table 18.** Decision Matrix and Values Assigned to the Indices of Biological, Chemical, and Physical Quality Using Comparison with a Reference Site and Comparison with Criteria (adapted from NMED 1998). ~ Continued.

<u>Decision</u>	<u>Criteria for Decision</u>	<u>Value Assigned</u>
<i>Indicators of water toxicity (in situ, caged-fish bioassay [with flood effects removed])</i>		
Supported	No chronic toxicity	5
Partially Supported	Chronic toxicity in 1 test	3
Not Supported	Any acute toxicity or chronic toxicity in >1 test	1
<i>Indicator of sediment toxicity (laboratory test of pore water at 100 % dilution)</i>		
Supported	No chronic toxicity	5
Partially Supported	Chronic toxicity in 1 test	3
Not Supported	Any acute toxicity or chronic toxicity in > 1 test	1
<b>INDEX OF CHEMICAL QUALITY</b>		
<i>Indicators of surface water quality for coldwater aquatic life use support</i>		
Supported	Temperature $\leq 20^{\circ}\text{C}$	5
Partially Supported	Temperature $\leq 22.5^{\circ}\text{C}$	3
Not Supported	Temperature $\leq 25^{\circ}\text{C}$	1
Supported	Dissolved oxygen $\geq 6\text{ mg/l}$ at all times	5
Partially Supported	Few measurements of dissolved oxygen $< 6\text{ mg/l}$	3
Not Supported	Dissolved oxygen $\leq 5\text{ mg/l}$	1
Supported	No pH $< 6$ or $> 9$	5
Partially Supported	Few pH measurements $< 6$ or $> 9$	3
Not Supported	Many pH measurements $< 6$ or $> 9$	1



**Table 18.** Decision Matrix and Values Assigned to the Indices of Biological, Chemical, and Physical Quality Using Comparison with a Reference Site and Comparison with Criteria (adapted from NMED 1998). ~ Continued.

<u>Decision</u>	<u>Criteria for Decision</u>	<u>Value Assigned</u>
Supported	No conductivity measurement > 1.5 mS/cm <sup>2</sup>	5
Partially Supported	Few conductivity measurements > 1.5 mS/cm <sup>2</sup>	3
Not Supported	Many conductivity measurements > 1.5 mS/cm <sup>2</sup>	1
Supported	No turbidity (minus background) > 10 NTU	5
Partially Supported	No turbidity (minus background) > 25 NTU	3
Not Supported	No turbidity (minus background) > 50 NTU	1
Supported	Total phosphorus ≤ 0.1 mg/L	5
Partially Supported	Total phosphorus ≤ 6.3 mg/L	3
Not Supported	Total phosphorus > 6.3 mg/L	1
Supported	Total ammonia as N < 1.0 mg/L	5
Partially Supported	Total ammonia as N < as limited by pH	3
Not Supported	Total ammonia as N > as limited by pH	1
<i>Indicators of water quality criteria for coldwater aquatic life use</i>		
Supported	For the mean of any parameter, does not exceed any chronic criterion	5
Partially Supported	For the mean of any parameter, exceeds one chronic criterion	3
Not Supported	Exceeds any acute criterion or multiple chronic criteria	1

**Table 18.** Decision Matrix and Values Assigned to the Indices of Biological, Chemical, and Physical Quality Using Comparison with a Reference Site and Comparison with Criteria (adapted from NMED 1998). ~ Continued.

<u>Decision</u>	<u>Criteria for Decision</u>	<u>Value Assigned</u>
<i>Indicators of regional water quality criteria for coldwater aquatic life use</i>		
Supported	Exceeds chronic criteria < 80% of reference	5
Partially Supported	Exceeds chronic criteria < 51 to 80 % of reference	3
Not Supported	Exceeds chronic criteria ≥ 50 % reference	1
<i>Indicators of sediment quality criteria for aquatic life use</i>		
Supported	Mean of any parameter does not exceed any Sediment Concentration of Concern	5
Partially Supported	Mean of ≥ 1 parameter exceeds Sediment Concentration of Concern	3
Not Supported	Mean of parameter exceeds Sediment Quality Criterion	1
<i>Indicators of tissue quality for aquatic life and wildlife health</i>		
Supported	Mean of any parameter does not exceed any Tissue Quality Criterion	5
Partially Supported	Mean of any 1 parameter exceeds Tissue Quality Criterion	3
Not Supported	Mean of > 1 parameter exceeds Tissue Quality Criterion	1
<b>INDEX OF PHYSICAL QUALITY</b>		
<i>Indicator of stream channel stability (Level III channel classification by Rosgen 1996)</i>		
Supported	Pfankuch rating = GOOD or EXCELLENT	5
Partially Supported	Pfankuch rating = FAIR	3
Not Supported	Pfankuch rating = POOR	1

**Table 18.** Decision Matrix and Values Assigned to the Indices of Biological, Chemical, and Physical Quality Using Comparison with a Reference Site and Comparison with Criteria (adapted from NMED 1998). ~ Continued.

<u>Decision</u>	<u>Criteria for Decision</u>	<u>Value Assigned</u>
<i>Habitat quality for aquatic invertebrates (Rapid Bioassessment Protocol [RBP])</i>		
Supported	RBP score > 80% of reference site	5
Partially Supported	RBP score > 50 to 80% of reference site	3
Not Supported	RBP score ≤ 50% of reference site	1
<i>Habitat quality for adult brook trout (using a Habitat Suitability Index [HSI])</i>		
Supported	HSI score > 80% of reference site	5
Partially Supported	HSI score > 50 to 80% of reference site	3
Not Supported	HSI score ≤ 50% of reference site	1
<i>Habitat quality for juvenile brook trout</i>		
Supported	HSI score > 80% of reference site	5
Partially Supported	HSI score > 50 to 80% of reference site	3
Not Supported	HSI score ≤ 50% of reference site	1
<i>Habitat quality for brook trout fry</i>		
Supported	HSI score > 80% of reference site	5
Partially Supported	HSI score > 50 to 80% of reference site	3
Not Supported	HSI score ≤ 50% of reference site	1
<i>Habitat quality for brook trout eggs</i>		
Supported	HSI score > 80% of reference site	5
Partially Supported	HSI score > 50 to 80% of reference site	3
Not Supported	HSI score ≤ 50% of reference site	1

**Table 18.** Decision Matrix and Values Assigned to the Indices of Biological, Chemical, and Physical Quality Using Comparison with a Reference Site and Comparison with Criteria (adapted from NMED 1998). ~ Continued.

<u>Decision</u>	<u>Criteria for Decision</u>	<u>Value Assigned</u>
<i>Habitat quality for longnose dace</i>		
Supported	HSI score > 80% of reference site	5
Partially Supported	HSI score > 50 to 80% of reference site	3
Not Supported	HSI score ≤ 50% of reference site	1
<i>The Habitat Quality Index (HQI as per Binns [1978])</i>		
Supported	HQI score > 80% of reference site	5
Partially Supported	HQI score > 50 to 80% of reference site	3
Not Supported	HQI score ≤ 50% of reference site	1

**Table 19. Benthic Invertebrate Community Metrics (Determined using data collected by Ford-Schmid [1999]) from Four Sites in the Canyon Streams Studied for the LANL Water Quality Assessment, 1996-1997.**

Parameter	Site VA 2.6	Site PA 9.0	Site SA 7.64	Site LA 13.0 <sup>a</sup>
Date Collected	22-Jul-1994	12-May-1997	20-Mar-1996	25-Feb-1997
Canyon	Valle	Pajarito	Sandia	Los Alamos
Density (number per meter <sup>2</sup> )	3,100	2,589	1,962	10,914
Richness (number of taxa)	33	25	10	42
Community Tolerance Dominance Quotient (CTQ <sub>d</sub> )	91.4	80	99.5	71.4
EPT <sup>b</sup> Index	6	10	3	18
EPT/(EPT + Chironomidae)	0.66	0.84	0.99	0.25
Percent Dominant Taxa	20	21	52	32
Community Loss	0.91	1.16	3.80	0
<b>Percent of Reference</b>				
Density	28	23	17	100
Taxa Richness	78	59	23	100
CTQ <sub>d</sub>	78	89	71	100
EPT Index	33	55	16	100
EPT/(EPT + Chiron.)	> 100	> 100	> 100	100
<b>Metric Score</b>				
Density	2	2	0	6
Taxa Richness	4	2	0	6
CTQ <sub>d</sub>	4	6	4	6
EPT Index	0	0	0	6
EPT/(EPT + Chiron.)	6	6	6	6
Percent Dominant Taxa	2	4	0	2
Community Loss	6	4	4	6
<b>Biological Condition</b>				
Total of Metric Scores	24	24	14	38
% of Reference Condition	63 (slightly impaired)	63 (slightly impaired)	37 (moderately impaired)	100 (reference condition)
<sup>a</sup> Reference stream segment for this study, used as reference site for these analyses. <sup>b</sup> EPT=Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies).				

**Table 20.** Comparison of Maximum Sediment Concentrations Provided by LANL (1998) with Sediment Quality Criteria and Grouped by Watershed and Analyte.

Analyte	Units	Los Alamos	Sandia	Water	Pajarito	Sediment Quality Criteria (Table 8)
Aluminum	mg/kg	7,140	7,100	21,000	15,000	580,300
Arsenic	mg/kg	<b>65.0<sup>a</sup></b>	1.1	2.4	3	39
Barium	mg/kg	264	299	247	220	
Beryllium	mg/kg	0.6	0.6	1.3	0.4	
Boron	mg/kg	33.2	20	25	7.7	
Cadmium	mg/kg	0.8	4	4	1.8	7
Chromium	mg/kg	15	12	12	14	176
Copper	mg/kg	6.8	5.6	12	6.5	146
Iron	mg/kg	22,000	18,300	16,000	16,000	32,500
Lead	mg/kg	28	20	20	139	189
Manganese	mg/kg	400	350	390	620	1,096
Mercury	mg/kg	<b>2.0</b>	<b>0.1</b>	<b>0.1</b>	<b>0.3</b>	0.002
Molybdenum	mg/kg	2	2	2	5.5	
Nickel	mg/kg	14.9	11	6.3	11.4	51
Selenium	mg/kg	<b>68</b>	0.4	0.5	0.5	
Silver	mg/kg	<b>7.5</b>	<b>8</b>	2	2	2.7
Strontium	mg/kg	41	29	95	19	
Uranium	mg/kg	12	4.1	3.7	5.6	
Vanadium	mg/kg	42	43	24	25	
Zinc	mg/kg	93	77	47	386	562

<sup>a</sup> Bolded values are above the Sediment Quality Criterion (or considered elevated as was selenium).

**Table 21.** Descriptive Statistics (Mean  $\pm$  Standard Deviation) for Elements Dissolved in Canyon Waters (N=40, 10 from each stream) Collected for the Los Alamos National Laboratory Use Study, and Water Quality Standards for New Mexico.

Element ( $\mu\text{g/L}$ )	Los Alamos	Sandia	Pajarito	Valle	Fisheries <sup>a</sup> Acute Chronic		Livestock watering	Irrigation	Water Supply
Aluminum	<b>877 <math>\pm</math> 461<sup>b</sup></b>	<b>184 <math>\pm</math> 91</b>	<b>3,690 <math>\pm</math> 4,234</b>	<b>798 <math>\pm</math> 504</b>	<i>750<sup>b</sup></i>	<i>87</i>	5000	5000	
Barium	25.6 $\pm$ 3.9	26.3 $\pm$ 6.6	49.1 $\pm$ 15.8	<b>3,332 <math>\pm</math> 843</b>					<i>1000</i>
Beryllium	0.3 $\pm$ 0.1	0.3 $\pm$ 0.1	0.4 $\pm$ 0.2	0.2 $\pm$ 0.1	130	5.3			
Boron	ND	60.1 $\pm$ 11.1	ND	27.2 $\pm$ 29.0			5000	750	
Cadmium	<b>1.8 <math>\pm</math> 1.2</b>	<b>2.6 <math>\pm</math> 1.0</b>	<b>2.1 <math>\pm</math> 0.7</b>	<b>2.1 <math>\pm</math> 1.0</b>	<i>1.8</i>	<i>0.7</i>	50	10	10
Chromium	3.2 $\pm$ 2.8	9.1 $\pm$ 2.6	4.5 $\pm$ 2.2	9.5 $\pm$ 14.6	980	120	1000	100	50
Copper	2.2 $\pm$ 1.6	(6.7 $\pm$ 2.1) <sup>b</sup>	4.1 $\pm$ 2.2	3.3 $\pm$ 2.1	9.2	6.5	500	200	
Iron	275 $\pm$ 136	375 $\pm$ 153	1,532 $\pm$ 1,773	430 $\pm$ 246		<i>1000</i>			
Magnesium	3,254 $\pm$ 155	5,415 $\pm$ 1,142	3,703 $\pm$ 674	5,364 $\pm$ 247					
Manganese	4.5 $\pm$ 4.2	46 $\pm$ 16	11.6 $\pm$ 7.8	29.9 $\pm$ 29.0					
Molybdenum	ND	88.5 $\pm$ 91.8	ND	ND				1000	
Nickel	3.9 $\pm$ 2.7	6.6 $\pm$ 2.8	6.0 $\pm$ 2.2	16.4 $\pm$ 30.7	790	88			
Strontium	67.8 $\pm$ 7.7	82.2 $\pm$ 27.9	72.0 $\pm$ 10.2	133.1 $\pm$ 11.6					
Vanadium	2.7 $\pm$ 2.4	11.7 $\pm$ 2.7	5.4 $\pm$ 2.9	4.0 $\pm$ 2.9			100	100	
Zinc	5.9 $\pm$ 2.3	27.2 $\pm$ 7.0	10.5 $\pm$ 5.0	7.0 $\pm$ 2.7	65	59		2000	

<sup>a</sup> For standards that are dependent on hardness, a default hardness value of 50 was used in the derivation of the standard above.

<sup>b</sup> In the row, bolded values are greater than the standards that are italicized. Copper was not elevated when a site-specific hardness was used.

**Table 22.** Descriptive Statistics\* (Mean  $\pm$  Standard Deviation) for Elements Dissolved in Canyon Waters Collected for the LANL Water Quality Assessment along with Water Quality Criteria for New Mexico (NMWQCC 1995).

Element ( $\mu\text{g/L}$ )	Los Alamos	Sandia	Pajarito	Valle	Fisheries <sup>a</sup> Acute Chronic		Livestock watering	Irrigation	Water Supply
Aluminum	<b>877 <math>\pm</math> 461<sup>b</sup></b>	<b>184 <math>\pm</math> 91</b>	<b>3,690 <math>\pm</math> 4,234</b>	<b>798 <math>\pm</math> 504</b>	<i>750<sup>b</sup></i>	<i>87</i>	5,000	5,000	
Barium	25.6 $\pm$ 3.9	26.3 $\pm$ 6.6	49.1 $\pm$ 15.8	<b>3,332 <math>\pm</math> 843</b>					<i>1,000</i>
Beryllium	0.3 $\pm$ 0.1	0.3 $\pm$ 0.1	0.4 $\pm$ 0.2	0.2 $\pm$ 0.1	130	5.3			
Boron	ND	60.1 $\pm$ 11.1	ND	27.2 $\pm$ 29.0			5,000	750	
Cadmium	<b>1.8 <math>\pm</math> 1.2</b>	<b>2.6 <math>\pm</math> 1.0</b>	<b>2.1 <math>\pm</math> 0.7</b>	<b>2.1 <math>\pm</math> 1.0</b>	<i>1.8</i>	<i>0.7</i>	50	10	10
Chromium	3.2 $\pm$ 2.8	9.1 $\pm$ 2.6	4.5 $\pm$ 2.2	9.5 $\pm$ 14.6	980	120	1,000	100	50
Copper	2.2 $\pm$ 1.6	6.7 $\pm$ 2.1 <sup>b</sup>	4.1 $\pm$ 2.2	3.3 $\pm$ 2.1	9.2	6.5	500	200	
Iron	275 $\pm$ 136	375 $\pm$ 153	<b>1,532 <math>\pm</math> 1,773</b>	430 $\pm$ 246		<i>1,000</i>			
Magnesium	3,254 $\pm$ 155	5,415 $\pm$ 1,142	3,703 $\pm$ 674	5,364 $\pm$ 247					
Manganese	4.5 $\pm$ 4.2	46 $\pm$ 16	11.6 $\pm$ 7.8	29.9 $\pm$ 29.0					
Molybdenum	ND	88.5 $\pm$ 91.8	ND	ND				1,000	
Nickel	3.9 $\pm$ 2.7	6.6 $\pm$ 2.8	6.0 $\pm$ 2.2	16.4 $\pm$ 30.7	790	88			
Strontium	67.8 $\pm$ 7.7	82.2 $\pm$ 27.9	72.0 $\pm$ 10.2	133.1 $\pm$ 11.6					
Vanadium	2.7 $\pm$ 2.4	11.7 $\pm$ 2.7	5.4 $\pm$ 2.9	4.0 $\pm$ 2.9			100	100	
Zinc	5.9 $\pm$ 2.3	27.2 $\pm$ 7.0	10.5 $\pm$ 5.0	7.0 $\pm$ 2.7	65	59		2,000	

<sup>a</sup> When a criterion was dependent on hardness, then the default hardness value of 50 was used in the derivation of the criterion.

<sup>b</sup> In the row, bolded values were greater than the criteria that are italicized. See text for why copper does not exceed criteria.

\* Note mean and standard deviation computed on the 10 samples from each stream.



**Table 23.** Concentrations of Explosive Compounds in Water Collected From Valle Canyon and Water Screening Benchmarks for Aquatic Life and Drinking Water.

Compound <sup>a</sup> (µg/L)	Valle Range (N=3)	Water-Screening Benchmark for Acute Effects	Water-Screening Benchmark for Chronic Effects	Human Health- Drinking Water
RDX	13.2 - 542 (mean = 221)	1,400 <sup>b</sup>	190 <sup>b</sup>	0.3 <sup>c</sup>
HMX	5.6 - 172 (mean = 78)	3,800 <sup>b</sup>	330 <sup>b</sup>	Not determined
4,2,6-DNT	0.5 - 48.6 (mean = 22.9)	Not determined	Not determined	0.05 <sup>c</sup>
2,4,6-DNT	1.1 - 22.5 (mean = 13.1)	350 <sup>b</sup>	20 <sup>b</sup>	0.05 <sup>c</sup>

<sup>a</sup> See Table 5 for chemical names and abbreviations.

<sup>b</sup> Talmage *et al.* 1999.

<sup>c</sup> USEPA 1999, IRIS database search on June 27,2000, using carcinogenic endpoints.

**Table 24.** Mean Concentrations ( $\mu\text{g/g}$ , dry weight) in Canyon Sediments Collected for the LANL Water Quality Assessment Compared to Thresholds of Concern.

Chemical <sup>1</sup>	CANYON				THRESHOLDS OF CONCERN			
	Los Alamos	Sandia	Pajarito	Valle	SQC <sup>2</sup>	Background <sup>3</sup>	SAL <sup>4</sup>	SAL/SQC <sup>5</sup>
Ag	0.1	0.6	0.8	0.5	2.7	3.0	380	139
Al	3,774	4,504	4,239	4,546	580,300	15,400	78,000	0.1
As	0.8	0.9	1.8	1.1	39	0.8		
Ba	35.1	55.6	64.2	1,022	40	127	5,300	133
Be	0.8	0.6	0.6	0.6		1.3		
B	1.5	2.0	1.2	1.6		64	5,900	
Cd	0.09	0.31	0.25	0.23	6.7	0.4	38.0	5.7
Cr	3.7	114.0	4.3	4.5	176	10.5	210	1.2
Cu	2.7	9.8	5.8	23.6	146	11.2	2,800	19.2
Fe	4,355	7,957	7,140	8,250	32,500	13,800		
Hg	<0.12	0.07	<0.10	<0.10	0.002		23	14,663
Mg	468	777	626	808		2,370		
Mn	153	269	380	399	1,096	543	390	0.4
Mo	0.3	1.9	0.4	0.4		3	380	
Ni	2.9	3.7	7.4	5.8	51	9.4	1,500	30
Pb	10.6	12.1	19.1	20.8	189	19.7	400	2.1
Se	0.3	0.2	0.2	0.3		0.3	380	
Sr	8.6	9.3	8.0	8.4		20	46,000	
V	5.28	8.38	11.97	9.54		19.7	540	
Zn	21.4	71.4	19.5	45.0	562	60.2	23,000	41
PCBs	<0.001	0.14	<0.002	0.03	0.35			
DNB	<0.03	<0.03	<0.03	<0.03	0.3			
HMX	<0.03	<0.03	<0.03	0.60	0.2			
RDX	<0.03	<0.03	<0.03	0.56	0.7			
TNT	<0.03	<0.03	<0.03	0.10	4.6			

<sup>1</sup> See Table 5 for abbreviations and chemical names, "<" = less than.

<sup>2</sup> Consensus-based Sediment Quality Criteria (see text and Table 8).

<sup>3</sup> Background Concentration in Canyon Sediments (per Rytí *et al.* 1998).

<sup>4</sup> Los Alamos National Laboratory Screening Action Level (per LANL 1998a).

<sup>5</sup> Ratio of SAL-to-SQC. A Ratio >1 indicated the SAL was likely unprotective of aquatic life and the environment (see text).

**Table 25.** Mean (and Standard Deviation) of Texture (Sand, Silt, Clay), Moisture, and Total Organic Carbon Content in Sediment Samples Collected for the LANL Water Quality Assessment 1996-1997.

Canyon Stream Segment	SAND (%)	SILT (%)	CLAY (%)	TOC (%)	MSTR (%)
Los Alamos	86.3 (7.4) <sup>A</sup>	9.1 (4.3) <sup>A</sup>	4.6 (4.8) <sup>A</sup>	1.2 (0.6) <sup>A</sup>	34.6 (8.3) <sup>A</sup>
Sandia	78.1 (11.4) <sup>A</sup>	16.0 (9.2) <sup>A</sup>	5.8 (2.8) <sup>A</sup>	0.8 (0.3) <sup>AB</sup>	25.0 (5.1) <sup>A</sup>
Pajarito	88.1 (7.8) <sup>A</sup>	8.3 (7.7) <sup>A</sup>	3.5 (0.8) <sup>A</sup>	0.4 (0.3) <sup>B</sup>	25.8 (5.3) <sup>A</sup>
Valle	86.3 (4.7) <sup>A</sup>	9.0 (3.0) <sup>A</sup>	4.7 (1.8) <sup>A</sup>	0.5 (0.3) <sup>AB</sup>	28.0 (7.9) <sup>A</sup>

For each column, superscript letters in common were not significantly different ( $p \leq 0.05$ , using a One Way Analysis of Variance)

TOC = Total Organic Carbon Content

MSTR = Moisture Content

**Table 26.** Comparison of Elements in Invertebrates Collected for the LANL Water Quality Assessment, and Reported in New Mexico.

Element ( $\mu\text{g/g}$ dry weight) <sup>a</sup>	Caddisfly Nymphs ( <i>Hesperophylax</i> sp.) collected on LANL		Failing 1993 ( <i>Hesperoperla pacifica</i> )	Lynch <i>et al.</i> 1988 (Mix of invertebrates)	Simpson and Lusk 1999 (Mix of invertebrates)	Popp <i>et al.</i> 1996 (Mostly stoneflies)	General Dietary Level of Concern for Fish and Wildlife <sup>b</sup>
	Caddisflies (without their cases)	Caddisflies (with cases on)	Comanche Creek	Red River (Upstream of Mine)	mainstream of the San Juan River	Villanueva Creek	
Al	249	2,806	252		3,310		>1,000
As	1.1	1.8			1.3		> 30
Ba	382	230			62.5		--
Be	0.03	0.3			0.1		> 3
B	3.4	1.6			4.5		> 30
Cd	0.5	0.3	0.4	1.9	0.3	1.3	> 0.5
Cr	16.8	12.4			2.9	2.1	> 10
Cu	17.2	5.7	73.1	43.0	23.3	11	40 - 80
Fe	533	5,156			2,070		>1,000
Pb	1.6	9.1		0.5	2.7	1.6	> 100
Mg	1,608	742			1,443		>10,000
Mn	412	967	79.5	240	261		> 1,000
Mo	14.7	1.5		2.8	0.7		> 30
Ni	10.6	5.3		7.1	2.3		> 300
Se	1.4	0.04			4.8		> 3
Sr	17.8	9.5			83		>5,000
V	1.6	10.7			5.9		> 30
Zn	169	49	397	320	117	239	> 180

<sup>a</sup> See Table 5 for abbreviations and chemical names.

<sup>b</sup> Based on NRC 1980, Eisler 1985, Eisler 1986a, Eisler 1987, Eisler 1993, Eisler 1994, and USDOI 1998.

**Table 27.** Elemental Concentrations in Fathead Minnow Caged in Streams for the LANL Water Quality Assessment, Compared with Concentrations in Fish Tissues Collected Nationwide and Regionally.

Element ( $\mu\text{g/g}$ wet weight) <sup>a</sup>	LANL Water Quality Assessment Whole-body Caged-Fish ( <i>Pimephales promelas</i> )		Fresquez <i>et al.</i> 1999 (Fish Fillets from the Rio Grande above and below the LANL)		Schmitt <i>et al.</i> 1999 (Whole Fish Collected Nationwide)	General Dietary Level of Concern - Predatory Wildlife <sup>b</sup>
	Prior to exposure (baseline)	after 2 months exposure	Maximum Background (above LANL)	Maximum (below LANL)	the 85 <sup>th</sup> percentile of geometric means	
Al	0.4	43.5				> 200
Ba	2.7	30.8	0.5	1.4		--
B	0.4	0.7				> 30
Cd	0.1	0.1	0.1	0.2	0.04	> 0.1
Cr	1.7	2.2	0.1	0.3		> 5
Cu	1.1	1.4	0.9	0.7	1.7	> 25
Fe	27.7	53.7				> 500
Mg	301	295				>3,000
Mn	0.8	5.8				> 400
Hg	0.02	0.03	0.3	0.2	0.2	> 0.1
Mo	0.1	0.2				> 10
Ni	1.1	1.2	1.1	0.9		> 50
Se	0.4	0.5	0.3	0.5	0.7	> 0.8
Sr	9.1	9.1				>2,000
V	0.2	0.3				> 10
Zn	41.8	38.6			31.7	> 40

<sup>a</sup> See Table 5 for abbreviations and chemical names.

<sup>b</sup> Based on NRC 1980, Eisler 1985, Eisler 1986a, Eisler 1987, Eisler 1993, Eisler 1994, and USDOJ 1998.

**Table 28.** Raw Habitat Suitability Index Scores for Various Life Stages of Brook Trout in Each Canyon Stream Segment Studied for the LANL Water Quality Assessment, 1996-1997.

<i>Variable Number</i> →		<i>V1</i>	<i>V2</i>	<i>V3</i>	<i>V4</i>	<i>V5</i>	<i>V6</i>	<i>V7</i>	<i>V8</i>	<i>V9</i>	<i>V10</i>
<i>SITE</i>	<i>Trout Life Stage</i>	<i>Summer High Temperature</i>	<i>Average Maximum Temperature</i>	<i>Minimum Dissolved Oxygen</i>	<i>Average Thalweg Depth</i>	<i>Riffle Flow</i>	<i>Percent Instream Cover</i>	<i>Average Gravel Size</i>	<i>Percent Large Substrates</i>	<i>Percent Riffle Substrates</i>	<i>Percent Pools</i>
Los Alamos	Adult	1	NA <sup>a</sup>	1	0.5	NA	1	NA	NA	0.6	0.7
Los Alamos, BR <sup>b</sup>	Adult	0.9	NA	0.7	0.2	NA	0.7	NA	NA	0.6	0.3
Los Alamos, DE <sup>c</sup>	Adult	1	NA	1	0.5	NA	1	NA	NA	0.6	0.7
Sandia	Adult	0.9	NA	0.7	0.55	NA	0.7	NA	NA	0.45	0.8
Pajarito	Adult	1	NA	1	0.3	NA	1	NA	NA	0.8	0.55
Valle	Adult	1	NA	0.75	0.05	NA	0.95	NA	NA	0.6	0.45
Los Alamos	Egg	1	1	1	NA	0.95	NA	0.95	NA	0.6	0.7
Los Alamos, BR	Egg	0.9	0.9	0.7	NA	0.6	NA	0.55	NA	0.6	0.3
Los Alamos, DE	Egg	1	1	1	NA	0.5	NA	0.95	NA	0.6	0.7
Sandia	Egg	0.9	0.7	0.7	NA	0.6	NA	0.55	NA	0.45	0.8
Pajarito	Egg	1	1	1	NA	0.35	NA	0.55	NA	0.8	0.55
Valle	Egg	1	1	0.75	NA	0.5	NA	0.95	NA	0.6	0.45
Los Alamos	Fry	1	NA	1	NA	NA	NA	NA	1	0.6	0.7
Los Alamos, BR	Fry	0.9	NA	0.7	NA	NA	NA	NA	1	0.6	0.3
Los Alamos, DE	Fry	1	NA	1	NA	NA	NA	NA	1	0.6	0.7
Sandia	Fry	0.9	NA	0.7	NA	NA	NA	NA	1	0.45	0.8
Pajarito	Fry	1	NA	1	NA	NA	NA	NA	1	0.8	0.55
Valle	Fry	1	NA	0.75	NA	NA	NA	NA	1	0.6	0.45
Los Alamos	Juvenile	1	NA	1	NA	NA	1	NA	NA	0.6	0.7
Los Alamos, BR	Juvenile	0.9	NA	0.7	NA	NA	0.9	NA	NA	0.6	0.3
Los Alamos, DE	Juvenile	1	NA	1	NA	NA	1	NA	NA	0.6	0.7
Sandia	Juvenile	0.9	NA	0.7	NA	NA	0.9	NA	NA	0.45	0.8
Pajarito	Juvenile	1	NA	1	NA	NA	1	NA	NA	0.8	0.55
Valle	Juvenile	1	NA	0.75	NA	NA	1	NA	NA	0.6	0.45

**Table 28.** Raw Habitat Suitability Index Scores for Various Life Stages of Brook Trout in Each Canyon Stream Segment Studied for the LANL Water Quality Assessment, 1996-1997 ~ *Continued.*

<i>Variable Number</i> ⇒		<i>V11</i>	<i>V12</i>	<i>V13</i>	<i>V14</i>	<i>V15</i>	<i>V16</i>	<i>V16a</i>	<i>Life Stage Score</i>	<i>Other Factors Score</i>	<i>HSI</i>	<i>Final HSI</i>
<i>SITE</i>	<i>Trout Life Stage</i>	<i>Bank Vegetation Score</i>	<i>Summer Bank Stability</i>	<i>pH</i>	<i>Estimated Baseflow</i>	<i>Pool Class</i>	<i>Percent Fines in Riffles</i>	<i>Percent Fines in Pools</i>				
Los Alamos	Adult	1	ND <sup>a</sup>	1	1	0.45	0.7	NA	0.66	0.91	0.77	0.77
Los Alamos, BR	Adult	1	ND	1	1	0.3	0.9	NA	0.35	0.88	0.56	0.20
Los Alamos, DE	Adult	1	ND	1	1	0.45	0.7	NA	0.66	0.91	0.77	0.77
Sandia	Adult	1	ND	1	1	1	0.95	NA	0.70	0.86	0.78	0.78
Pajarito	Adult	1	ND	1	1	0.3	0.95	NA	0.50	0.97	0.69	0.30
Valle	Adult	1	ND	1	1	0.3	0.6	NA	0.26	0.86	0.48	0.05
Los Alamos	Egg	1	ND	1	1	NA	0.7	0.2	0.57	NA	0.57	0.57
Los Alamos, BR	Egg	1	ND	1	1	NA	0.9	0.45	0.53	NA	0.53	0.53
Los Alamos, DE	Egg	1	ND	1	1	NA	0.7	0.2	0.46	NA	0.46	0.46
Sandia	Egg	1	ND	1	1	NA	0.95	0.5	0.55	NA	0.55	0.55
Pajarito	Egg	1	ND	1	1	NA	0.95	0.5	0.46	NA	0.46	0.46
Valle	Egg	1	ND	1	1	NA	0.6	0.15	0.42	NA	0.42	0.42
Los Alamos	Fry	1	ND	1	1	NA	0.7	NA	0.77	0.91	0.83	0.83
Los Alamos, BR	Fry	1	ND	1	1	NA	0.9	NA	0.53	0.88	0.68	0.68
Los Alamos, DE	Fry	1	ND	1	1	NA	0.7	NA	0.77	0.91	0.83	0.83
Sandia	Fry	1	ND	1	1	NA	0.95	NA	0.88	0.86	0.87	0.87
Pajarito	Fry	1	ND	1	1	NA	0.95	NA	0.73	0.97	0.84	0.84
Valle	Fry	1	ND	1	1	NA	0.6	NA	0.59	0.86	0.71	0.71
Los Alamos	Juvenile	1	ND	1	1	0.45	0.7	NA	0.72	0.91	0.81	0.81
Los Alamos, BR	Juvenile	1	ND	1	1	0.3	0.9	NA	0.50	0.88	0.66	0.30
Los Alamos, DE	Juvenile	1	ND	1	1	0.45	0.7	NA	0.72	0.91	0.81	0.81
Sandia	Juvenile	1	ND	1	1	1	0.95	NA	0.90	0.86	0.88	1.00
Pajarito	Juvenile	1	ND	1	1	0.3	0.95	NA	0.62	0.97	0.77	0.30
Valle	Juvenile	1	ND	1	1	0.3	0.6	NA	0.58	0.86	0.71	0.30

<sup>a</sup> Not applicable to the HSI model for this life stage.

<sup>b</sup> BR = Below the Los Alamos Reservoir.

<sup>c</sup> DE = Habitat measurements during electrofishing survey. See text.

<sup>d</sup> Not determined and this variable is optional for the brook trout HSI model. See Raleigh 1982.

**Table 29.** Raw Habitat Suitability Index Scores for Adult Longnose Dace in Each Canyon Stream Reach and Stream Segment Studied for the LANL Water Quality Assessment, 1996-1997.

<i>Variable Number</i>	<i>V1</i>	<i>V2</i>	<i>V3</i>	<i>V4</i>	<i>V5</i>	<i>V6</i>	
<i>SITE<sup>a</sup></i>	<i>Riffle Flow</i>	<i>Riffle Depth</i>	<i>Percent Riffle</i>	<i>Percent Large Substrates</i>	<i>Summer High Temperature</i>	<i>Percent Cover</i>	<i>HSI</i>
Upper Reach Los Alamos	0.75	0.25	1	0.6	0.65	1	0.25
Lower Reach Los Alamos	0.6	0.4	1	0.3		1	0.30
Los Alamos Segment	0.675	0.325	1	0.45	0.65	1	0.28
Los Alamos, BR <sup>b</sup>	0.95	0.25	1	0.6	1	0.65	0.25
Los Alamos, DE <sup>c</sup>	0.25	0.2	1	0.3	0.65	1	0.20
Upper Reach Sandia	0.45	0.2	1	1	1	0.75	0.20
Lower Reach Sandia	0.25	0.2	1	1		1	0.20
Sandia Segment	0.35	0.2	1	1	1	0.875	0.20
Upper Reach Pajarito	0.15	0.2	1	0.6	0.6	1	0.15
Lower Reach Pajarito	0.1	0.15	1	1		1	0.10
Pajarito Segment	0.125	0.175	1	0.8	0.6	1	0.13
Upper Reach Valle	0.3	0.2	1	0.6	1	1	0.20
Lower Reach Valle	0.3	0.2	1	0.45		1	0.20
Valle Segment	0.3	0.2	1	0.525	1	1	0.20

<sup>a</sup> See Figures 8 through 11 for location of habitat reaches in canyon stream segment studied.

<sup>b</sup> BR = Below the Los Alamos Reservoir.

<sup>c</sup> DE = Habitat measurements made during electrofishing survey. See text.



**Table 30.** Comparison of the Brook Trout HSI Model Parameter Ranges with Habitat Associations Reported by the New Mexico Department of Game and Fish (NMDGF 1998) and "Good-Excellent" Habitat Features Reported by Binns (1978) in the Habitat Quality Index (HQI).

<i>HSI Parameter</i>	<i>Code</i>	<i>HSI Range</i>	<i>HSI = 1.0</i>	<i>HSI = 0.0</i>	<i>NMDGF 1998</i>	<i>HQI</i>
<i>Max. Temp. - adult</i>	V1	0 - 30 °C	10 - 16 °C	0; 24 - 30 °C	<15 - 21 °C	10.5 - 21.1 °C
<i>Max. Temp. - embryo</i>	V2	0 - 20 °C	4 - 12 °C	0; 20 °C	<15 - 21 °C	NS <sup>a</sup>
<i>Min. Dissolved Oxygen</i>	V3a	3 - 9 mg/L	6.5 - 9.0 mg/L	3.0 mg/L	< 5 - >7 mg/L	NS
<i>Min. Dissolved Oxygen</i>	V3b	3 - 9 mg/L	9.0 mg/L	3.0 - 5.0 mg/L	5 - >7 mg/L	NS
<i>Mean Depth</i>	V4	0 - 60 cm	30 - 60 cm	0 - 12 cm	< 30 - 300 cm	NS
<i>Mean Flow</i>	V5	0 - 100 cm/sec	30 - 60 cm/sec	0; 90 - 100 cm/sec	15 - 76 cm/sec	30 - 91 cm/sec
<i>Percent Cover</i>	V6j	0 - 40%	14 - 40 %	N/A <sup>b</sup>	NS, some required	NS
<i>Percent Cover</i>	V6a	0 - 40%	22 - 40 %	N/A	NS, some required	41 - >55%
<i>Substrate Size</i>	V7	0 - 10 cm	2.5 - 6.0 cm	0.0 cm	2.0 - 256 cm	NS
<i>Covered Substrate</i>	V8	0 - 20%	8 - 20 %	0 %	NS	NS
<i>Dominant Substrate</i>	V9	N/A	Class A	N/A	Gravel (Class A)	NS
<i>Percent Pools</i>	V10	0 - 100 %	35 - 65 %	N/A	Preferred	NS
<i>Percent Bank Vegetation</i>	V11	0 - 300 %	150 - 300 %	N/A	NS	NS
<i>Percent Bank Stability</i>	V12	0 - 100 %	75 - 100 %	N/A	NS	76 - 100 %
<i>Max/Min pH</i>	V13	4.0 - 10.0	6.5 - 8.0	4.0; 9.5 - 10.0	NS	NS
<i>Estimated Base Flow</i>	V14	0 - 100 %	50 - 100 %	0 %	NS	26 - 55 %
<i>Pool Class Rating</i>	V15	N/A	≥ 30% 1 <sup>st</sup> Class	N/A	1 <sup>st</sup> Class	NS
<i>Percent Fines in Riffles</i>	V16	0 - 60 %	0 - 15 %	N/A	NS	NS

<sup>a</sup> None stated or quantified.

<sup>b</sup> Not applicable to HSI model for this life stage.

**Table 31.** Summary Results and Values Assigned for the Index of Biological Quality used in the Development of the Water Quality Index.

<i>Biological Survey Results (and Value Assigned)</i>	Valle	Pajarito	Sandia	Los Alamos
Fish Species	0 (1)	0 (1)	0 (1)	2 (5)
Shellfish Species	1 (5)	1 (5)	0 (1)	1 (5)
Aquatic Insect Taxa	33 (3)	25 (3)	10 (1)	42 (5)
Invertebrate Community Biological Condition Index	24 (3)	24 (3)	14 (1)	38 (5)
<i>Surface Water Toxicity</i>				
96-hour fish survival	98 (5)	93 (5)	95 (5)	93 (5)
7-day invertebrate survival	0 (1)	100 (5)	90 (5)	100 (5)
7-day invertebrate reproduction	0 (1)	21 (3)	21 (3)	35 (5)
<i>Caged Fish Bioassay</i>				
Corrected 96-hour survival (flood effects removed)	99 (5)	99 (5)	96 (5)	94 (5)
Corrected 2-month survival (flood effects removed)	94 (5)	73 (5)	93 (5)	77 (5)
2-month, average grams gained (flood effects removed)	1.4 (5)	1.7 (5)	1.8 (5)	1.5 (5)
<i>Sediment Pore Water Toxicity</i>				
7-day invertebrate survival	100 (5)	100 (5)	78 (5)	90 (5)
7-day invertebrate reproduction	31 (3)	32 (3)	13 (1)	41 (5)
Index of Biological Quality	42	48	38	60
% Index of Biological Quality Compared to the Reference Site	70	80	63	100

**Table 32.** Summary Results and Values Assigned for the Index of Chemical Quality used in the Development of the Water Quality Index.

<i>Summary Results of Water Quality Criteria Exceeded (and Value Assigned)</i>	Valle	Pajarito	Sandia	Los Alamos
Aquatic Life Acute Criteria	Al <sup>a</sup> (1)	Al (1)	_(5)	Al (1)
Aquatic Life Chronic Criteria	Al, RDX, HMX (1)	Al, Fe (1)	Al (3)	Al (3)
Dissolved Oxygen as mg/L	<6 (3)	< 6 (3)	<5 (1)	< 6 (3)
Temperature in Celsius	> 20 (3)	< 20 (5)	> 20 (3)	< 20 (5)
Conductivity as mS/cm	< 1.5 (5)	< 1.5 (5)	> 1.5 (3)	< 1.5 (5)
pH as standard units	> 9 (3)	< 9 (5)	< 9 (5)	< 9 (5)
Turbidity as NTU	> 10 (3)	> 25 (1)	> 10 (3)	> 10 (3)
Phosphorus	> 0.1 (3)	> 0.1 (3)	> 6.3 (1)	> 0.1 (3)
Ammonia as Nitrogen	< 1.0 (5)	< 1.0 (5)	< 1.0 (5)	< 1.0 (5)
<i>Sediment Quality Criteria Exceeded (Value Assigned)</i>				
Sediment Concentration of Concern Criteria	Al (3)	Al (3)	Al, Cr, PCB (1)	Al (3)
Sediment Quality Criteria	HMX, TNT (1)	_(5)	_(5)	_(5)
<i>Tissue Quality Criteria Exceeded (Value Assigned)</i>				
Tissue Quality Criteria	_(5)	Cr (3)	Cr, PCBs (1)	Cr (3)
Index of Chemical Quality	33	37	31	41
% Index of Chemical Quality Compared to Reference Site	80	90	76	100

<sup>a</sup> See Table 5 for abbreviations and chemical names.

<sup>b</sup> \_(5) = Did not exceed any criteria, value of 5 assigned.

**Table 33.** Summary Results and Values Assigned for the Index of Physical Quality used in the Development of a Water Quality Index

Physical Characteristic (and Value Assigned)	Valle	Pajarito	Sandia	Los Alamos
<i>Stream Channel Stability (per Rosgen 1996)</i>				
Pfankuch Rating	FAIR (3)	FAIR (3)	POOR (1)	FAIR (3)
<i>Aquatic Life Habitat Quality Model Results</i>				
Rapid Bioassessment Protocol for Invertebrate Habitat	173 (5)	178 (5)	129 (3)	176 (5)
Habitat Suitability Index for Brook Trout Eggs	0.42 (3)	0.46 (5)	0.55 (5)	0.57 (5)
Habitat Suitability Index for Brook Trout Fry	0.71 (5)	0.84 (5)	0.87 (5)	0.83 (5)
Final Habitat Suitability Index for Brook Trout Juveniles	0.30 (1)	0.30 (1)	1.0 (5)	0.81 (5)
Final Habitat Suitability Index for Brook Trout Adults	0.05 (1)	0.30 (1)	0.78 (5)	0.77 (5)
Binn's Habitat Quality Index	17.1 (1)	23.8 (1)	25.3 (1)	68.7 (5)
Final Habitat Suitability Index for Longnose Dace	0.2 (3)	0.2 (3)	0.2 (3)	0.3 (5)
Index of Physical Quality	22	24	28	38
% Index of Physical Quality Compared to Reference Site	58	63	74	100